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We judge ourselves by what we feel capable of doing; but the world judges us by what we have already done.

Longfellow.



T. J. DRUMMOND.

Pioneer in the enterprise of Iron Making in Canada.

Lord Bacon in his essay on "Riches," says:—

If a man can play the true logician, to have as well judgment as invention, he may do great matters, especially if the times be fit.

It is not often that we find combined in one man, mechanical instinct, business aptitude, and executive ability. Such personalities are rare, they appear only at intervals like meteors in the sky; but whenever they do appear, the inevitable corollary to their lives is *success*. Especially is this so in the domain of Industry. In the United States the man who was awarded by the American Society of Mechanical Engineers, the John Fritz medal for 1905—George Westinghouse—is a brilliant example.

Among the business men of Canada there is one who possesses in a marked degree the aforesaid three traits; who has justly been described as "the leading pioneer in the enterprise of iron making in the Dominion;" and whose portrait it is a pleasure to incorporate this month in our gallery of men who have "done things."

Thomas J. Drummond was born in Ireland 26th September, 1860, his family removing to Canada in the early sixties. He was educated in Montreal. In 1886 he founded, together with his brother, Mr. Geo. E. Drummond, and Mr. J. T. McCall, the well-known firm of Drummond, McCall & Co., iron and steel merchants. This house early in its career became interested in the industrial life of Canada, and may be ranked as pioneers in the enterprise of iron making in this country. What is known as the "Drummond Group" of iron industries, is perhaps as comprehensive a group of allied enterprises as the Dominion can claim. They embrace the work of:—

The Canada Iron Furnace Co., Ltd., at Midland, Ont., and Radnor Forges, Que.

The Londonderry Iron & Mining Co., Ltd., at Londonderry, N.S.

The Canadian Iron & Foundry Co., Ltd., with plants at Hamilton, Ont., and St. Thomas, Ont.

The Montreal Pipe Foundry Co., Ltd., works at Three Rivers, Que., and Londonderry, N.S.

He is a director in all these companies; president of the Londonderry Iron & Mining Co., Ltd., also of the Montreal Pipe Foundry Co., Ltd., (a fine modern plant, which we purpose describing and illustrating in an early number); and vice-president of the Canadian Iron & Foundry Co. These works combined, employ upwards of 2,600 men. In addition to his active interests in the companies mentioned, Mr. Drummond is vice-president of the Lake Superior Corporation, and was one of the most active spirits in the successful reorganization of that company. Outside of the iron industry he is interested in several corporations, being vice-president of the Montreal Water & Power Co. (of which corporation he was practically the originator), a company which now supplies all the suburbs of Montreal, and several of the wards of the city, with water. He is a leading director in the Drummond Mines, Limited, operating mines near Cobalt, Ont.

Mr. Drummond is also a director of the Imperial Life Assurance Co., of Canada, and is an Associate Member of the American Institute of Civil Engineers, and a member of the American Institute of Mining Engineers, and of the Canadian Mining Institute.

We are on the threshold of great things in iron and steel, and reasoning from the known to the unknown, we fear not to predict that Thomas Joseph Drummond—whose worthy business record we have briefly told, will play an important part in the industrial development of Canada.



Bird's Eye View of Niagara Falls Showing Power Developments on Canadian Side.

HYDRO-ELECTRIC ENTERPRISE IN CANADA

"THE DEVELOPMENT OF THE ONTARIO POWER COMPANY" AT NIAGARA FALLS.

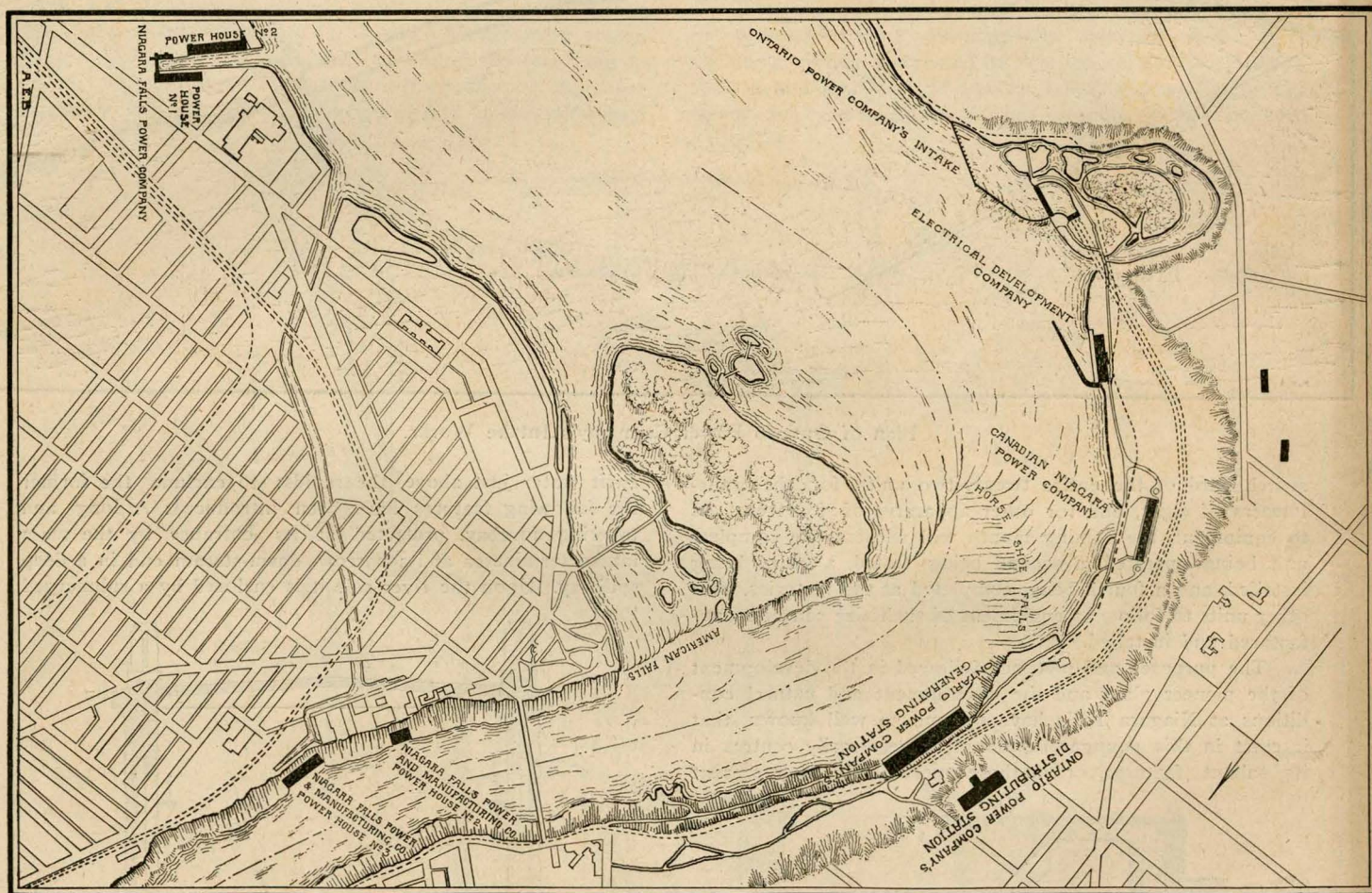
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BY PAUL N. NUNN, C.E.

Designer—in conjunction with his brother L. L. Nunn—of the Ontario Power Company's magnificent installation at the "Falls," which was inspected by the Canadian Society of Civil Engineers, Wednesday, January 31, 1906.

The development of electrical power at Niagara Falls has long attracted widespread attention and interest. Since the first installation upon the American side, descriptions and discussions of its works and methods have been granted a conspicuous place in technical records and scientific press. It is not so well known, however, that four other developments, each larger than the pioneer, are now drawing or preparing to draw power from Niagara river. These differ so widely and so apparently as to type and character, and express such differences of conception and method, that it seems fitting at this time, when the largest is about to enter the active field, to present to the technical world,

manding position, is by far the most prominent landmark of the Canadian side. This is the distributing station of the same company, from which the power generated below is controlled, measured and transmitted. Away to the left, around the bend of the river, and hidden by the trees of Goat Island, are the walls, abutments and buildings of the intake and head-gates through which the water from Niagara river is diverted for use below. In the park between these extremes, seen just beyond Horse Shoe Falls, stands the power-house of the Canadian Niagara Power Company, while to the left another power plant, that of the Electrical Development Company, is rapidly building.



Map of Niagara Falls, showing Location of Power Developments.

a brief description of a few features peculiar to this plant and a statement of the considerations which have led to so fundamental a departure from the type of construction hitherto characteristic of Niagara Falls.

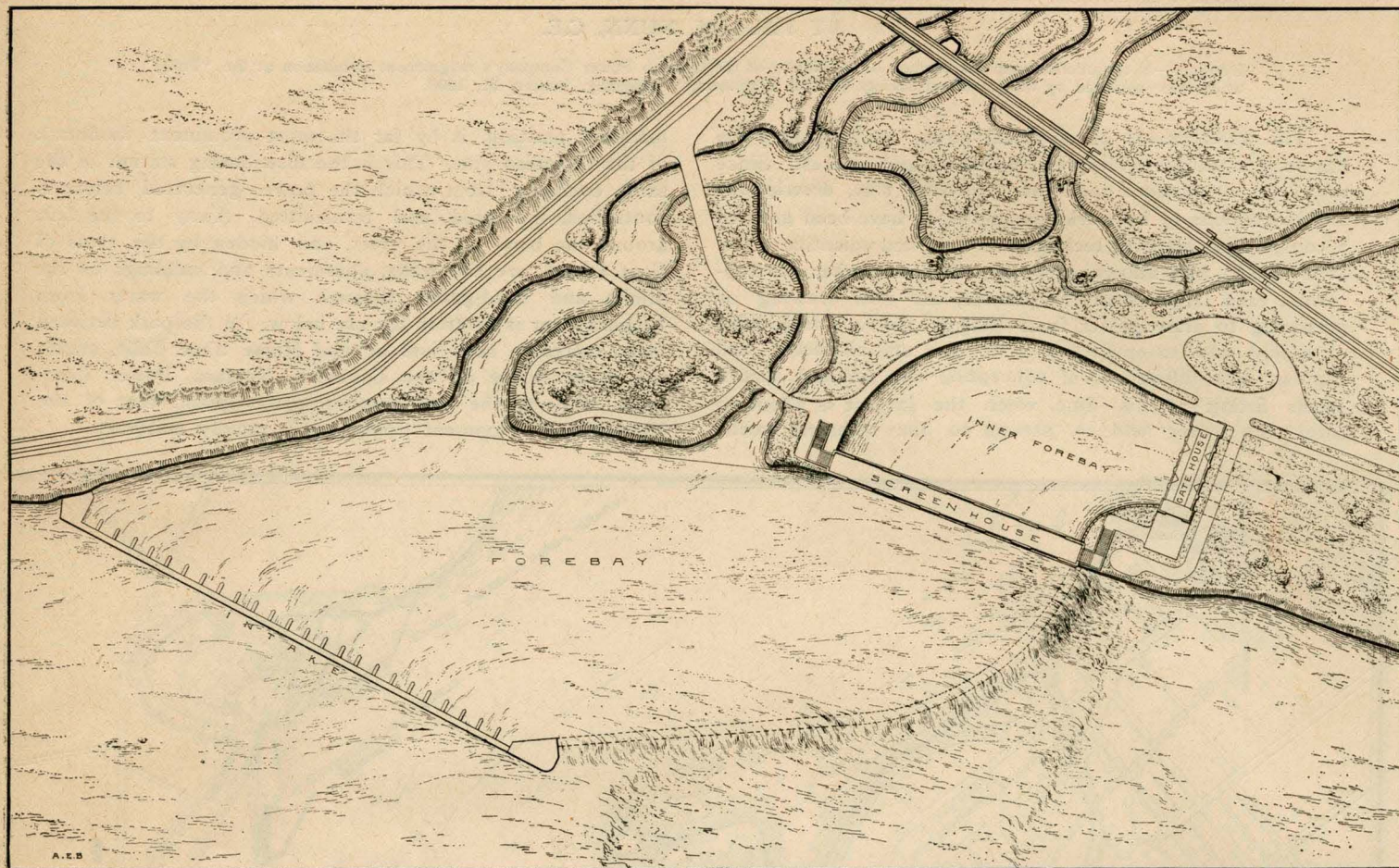
Standing upon the upper steel-arch bridge and facing the Canadian falls, one may observe at the foot of the cliff forming the right-hand wall of the gorge a long but unobtrusive building, its farther end obscured by spray from the great cataract. It is of modest though massive design, and its colors almost blend with those of the overhanging cliff. This is the power-house or generating station of the Ontario Power Company. To the right, high above and behind the power-house, upon the bluff overlooking both gorge and cataract, may be seen another great structure, less massive but more ornate, which, on account of its com-

From the head-gates of the Ontario company three great steel-and-concrete tunnels or conduits beneath the surface of the park will convey nearly 12,000 cubic feet of water per second to the top of the cliff above the power-house. Thence it will pass through twenty-two steel penstocks in shafts and tunnels down and out through the cliff to an equal number of horizontal turbines in the power-house below. From the generators the electrical cables turn back through tunnels to the twenty-two banks of switches, transformers and instruments of the distributing station above and to the transmission lines beyond, completing an equipment for more than 200,000 h.p.

The intake works for the entire 200,000 h.p. are now finished. One of the three main conduits is completed, while for the second and third, portals and head-works have been installed and a portion of the excavation made. Six

of the twenty-two penstocks are already in place within their shafts and tunnels and two others are building, while the power-house is nearly prepared for the concomitant apparatus. The distributing station is completed for the

from the Great Lakes, and mush ice is formed in the turbulent rapids primarily by the freezing of spray and foam, and secondarily by the disintegration of cake ice. To avoid the latter the intake is located in the smooth but

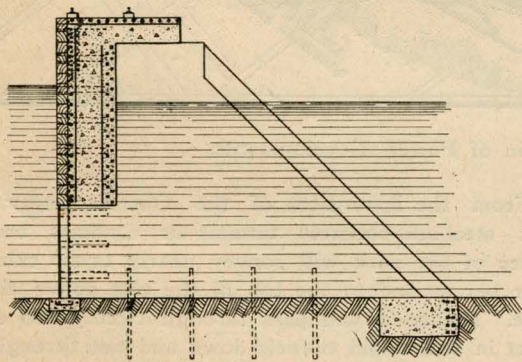


Plan of Ontario Power Company's Intake Works.

switchboard of the entire twenty-two units, for the transformers of eight, and for other apparatus of fourteen. As to equipment, the coming month will witness one complete unit being operated, a second being tested, a third being installed, and a fourth being completed at the factories, with other units to follow as equipment of such size can be manufactured and installed.

The purposes and methods followed in the development of the pioneer plant and the environment and natural conditions at Niagara Falls have become so well known that interest in this younger development necessarily centres in its salient features, or in those most likely to represent

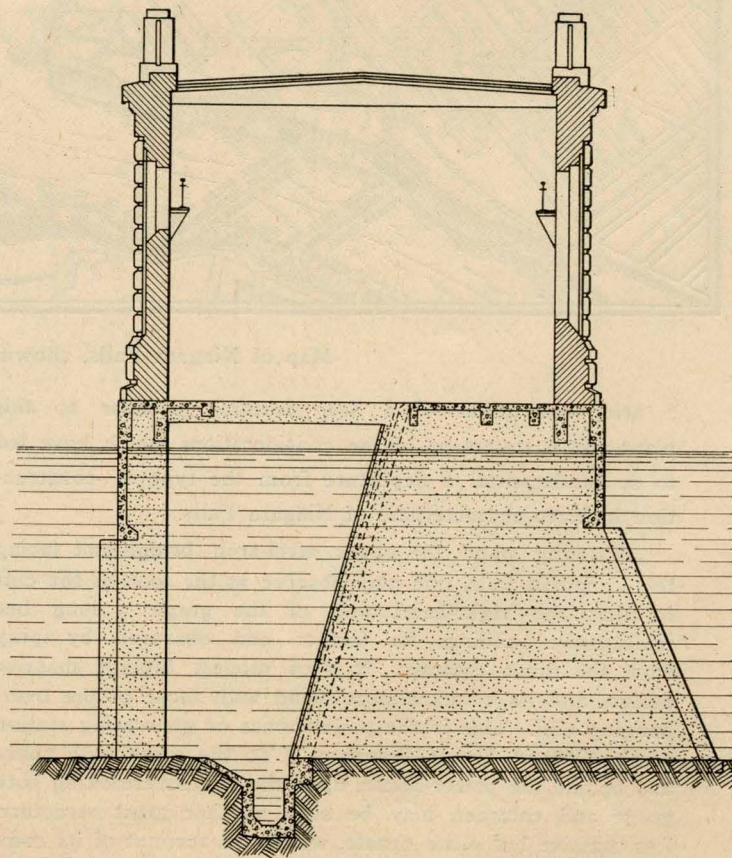
swift water just above the rapids; to exclude the former the following features have been introduced: A long and tapering forebay, protected at its entrance by the main intake terminates at its narrow, down-stream end in a deep spillway. Upon the river side it is enclosed by a submerged



Section Through Intake.

advance in engineering. The more important of these are the arrangement of intake works, the design of main conduit and spillway, the horizontal shaft units, the symmetry of arrangement, the centralization of control, and the protective isolation of apparatus.

The intake works have been located and designed with especial reference to the ice difficulties, which have been the limiting factor in the success of Niagara power. Cake ice in enormous quantities floats down for weeks at a time

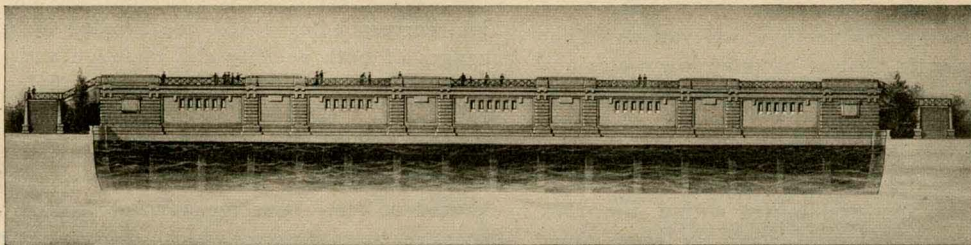


Section through Screen House.

wall, while the other side adjacent to the spillway is occupied by the main screen structure leading to the inner bay and to the portals and head-gates of the three conduits.

The intake, nearly 60 feet long, stretches across the inlet or bay at Dufferin Island almost parallel with the current in the river. Throughout its length a concrete curtain-wall extends down nine feet into the water, here fifteen

screens, which are also enclosed and safeguarded by a curtain carried by the front wall of the gate-house. The bay in front of the curtain communicates with the river by an ample ice-run. Substantial concrete buildings shelter both head-gates and main screens. In each case an open canal between curtain and screen spills into a gravity ice-run emptying into the river. Both buildings are supplied with

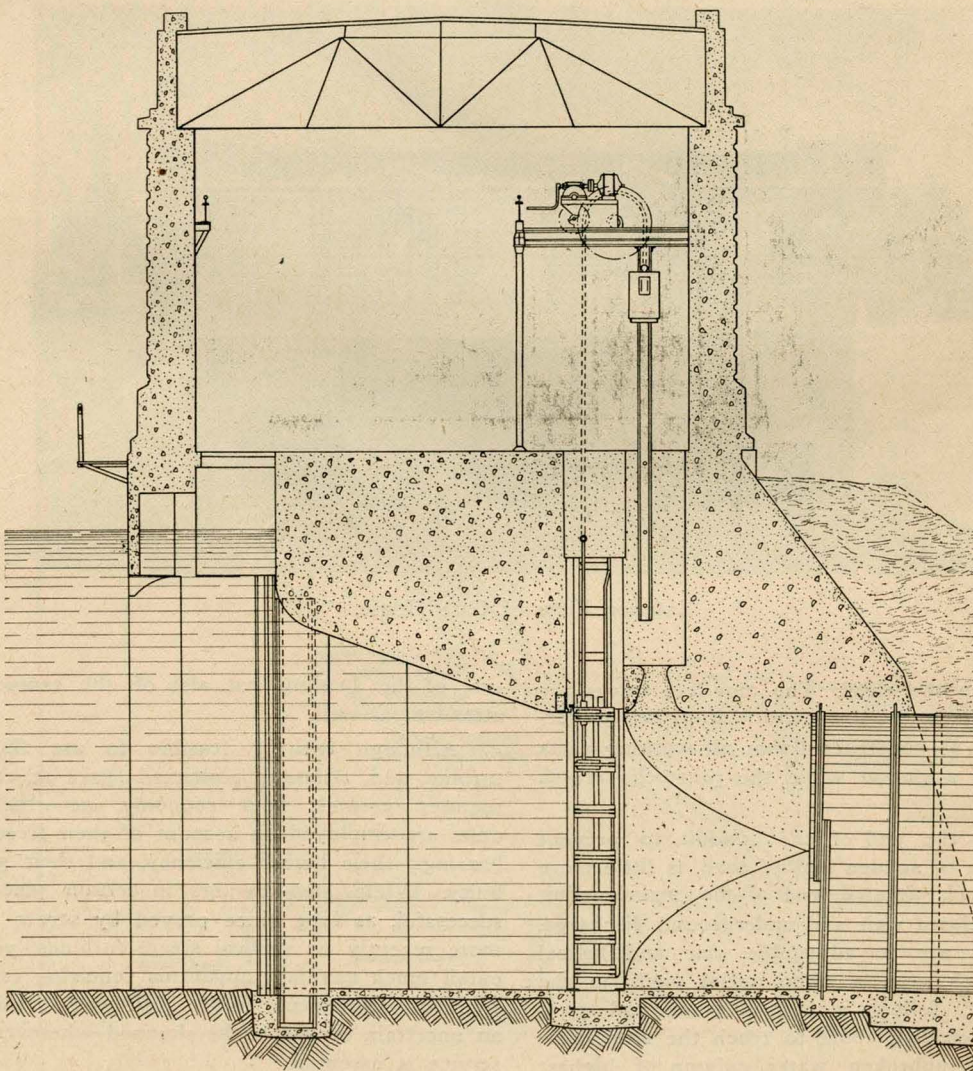


Screen House and Promenade.

feet deep, so that the gate openings beneath admit only deep water, and this at right angles to the swift exterior surface flow, which, sweeping the full length of the curtain, carries the floating ice to the rapids beyond. At the main screen this operation is repeated. This structure, 320 feet long in twenty feet of water, lies across the entrance to the inner bay and parallel with the direction of flow in the outer bay.

steam for heating and thawing from an underground boiler-plant situated in the common abutment.

Thus the water before entering the conduits must pass in succession three automatically selective steps, each excluding surface water and its floating ice, and two screens, each behind ice-runs in heated buildings containing live steam for emergencies. Serious trouble is not believed



Section through Gate House.

Again a curtain, formed by the front wall of the enclosing superstructure, admits to the screens only deep water, here also at right angles, while it excludes ice with the surface currents maintained through the forebay by a voluminous spill of surplus water.

At the gate structure, where the water is thirty feet in depth, the tapering portals leading to the electrically operated Stoney head-gates are protected with wide-mesh

possible while these provisions are maintained with reasonable care.

Screen frames are removable by an electric crane for cleaning and changing. On account of its location in the public park, the top of the long, narrow screen-house, approached at either end by broad steps and landings, is finished as a promenade. From this point of vantage one may have a superb view of the upper rapids. The islands

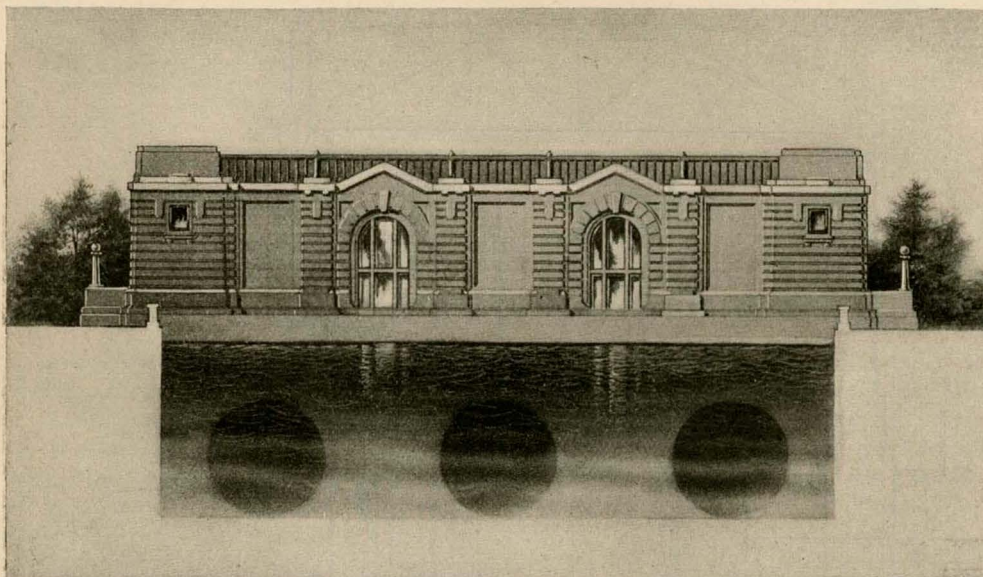
and channels made in the course of this work give great opportunity to make this portion of the park most picturesque.

The height of the water in Niagara river, and, therefore, the volume here available, is dependent upon the surface elevation of Lake Erie, the erosion of the river bed, and such temporary causes, as ice gorges, storms, etc. From calculations based upon comparative observations extending over a number of years and upon Government reports of Lake Erie levels for nearly fifty years, the elevations of the intake have been so selected that at extreme low water and most adverse conditions a full supply of water should be secured.

The main conduits are of 0.5 in. riveted and reinforced steel embedded in concrete, eighteen and twenty feet in diameter, 6,500 feet long, and are buried within the rock and soil of the public park. Through them the water flows at a velocity of approximately fifteen feet per second. Just beneath the top of the cliff behind the power-house, within a long underground chamber, the arched roof of which supports the conduit above, nine-foot diameter branches pass from the under side of the conduit through gate-valves and become the penstocks, each supplying water at ten feet per second to a single turbine. Each penstock has two expansion joints, a massive thrust anchorage in the power-house foundations, and an automatic relief-valve and a stone-

two 78 in. cast-steel runners of "normal" reaction. Housings are of reinforced steel plate, 16 feet in diameter, spiral in elevation and rectangular in plan. Gates are of the wicket or paddle type, and the rotating guides forming them are carried by shafts which project through stuffing boxes to an external controlling mechanism, thus freeing the casings from the objectionable interior gate-rigging and leaving their approaches to the guides symmetrical and open. While the velocities in housings and draft-tubes are high, corresponding losses are avoided by nicely modulated changes of both velocity and direction and by symmetrical and liberal curves free from abrupt angles or obstructing projections.

Of the 175 feet head, 20 feet is in the 10 feet diameter draft-tubes, because the floor of the power-house has been elevated 26 feet above mean water level to provide for the excessive variations to which the water in the gorge is subject. While bearings are self-oiling, all are equipped with water-cooling system, and for still greater insurance a piping system for the changing of oil has been so connected that in emergency it is instantly available for forced lubrication. Believing that disorders of bearings and journals, like those of people, are usually the culmination of gradually increasing ailment, each bearing is supplied with an automatic record-making thermometer, providing the superintendent with a daily record, not only of the tempera-



Exterior View of Gate House.

catch discharging into the river. The nine-foot valves are electrically operated under distant control from the power-house below, and are so constructed that all working parts may be removed for attention while the penstocks are in service.

The spillway at the end of the conduit, to prevent water-hammer in case of sudden loss of load, is little more than the enlarged and elevated end of the main conduit equipped with an enclosed weir and underground discharge. Its peculiar features are its adjustable weir and helical discharge-tunnel, which, after a steep initial pitch in the taper from the weir, follows a uniform grade and symmetrical curve while circling about to reach the river, thus preserving a smooth, unbroken water column of highest velocity and least expenditure of energy. The purpose here is to prevent erosion, restricted flow and excessive air-suction, the latter on account of the danger of formation of ice from spray under forced circulation of air.

The generators are of conventional horizontal-shaft type, three-phase, 25-cycle, and deliver 12,000 volts at 187.5 revolutions per minute. The turbines are of Francis or inward-flow type, double, central-discharge or balanced twin turbines, designed to deliver 12,000 h.p. under 175 feet head. Their shafts are 24 in. maximum diameter, and each carries

ture of the bearing, but also of the temperament of the attendant as well.

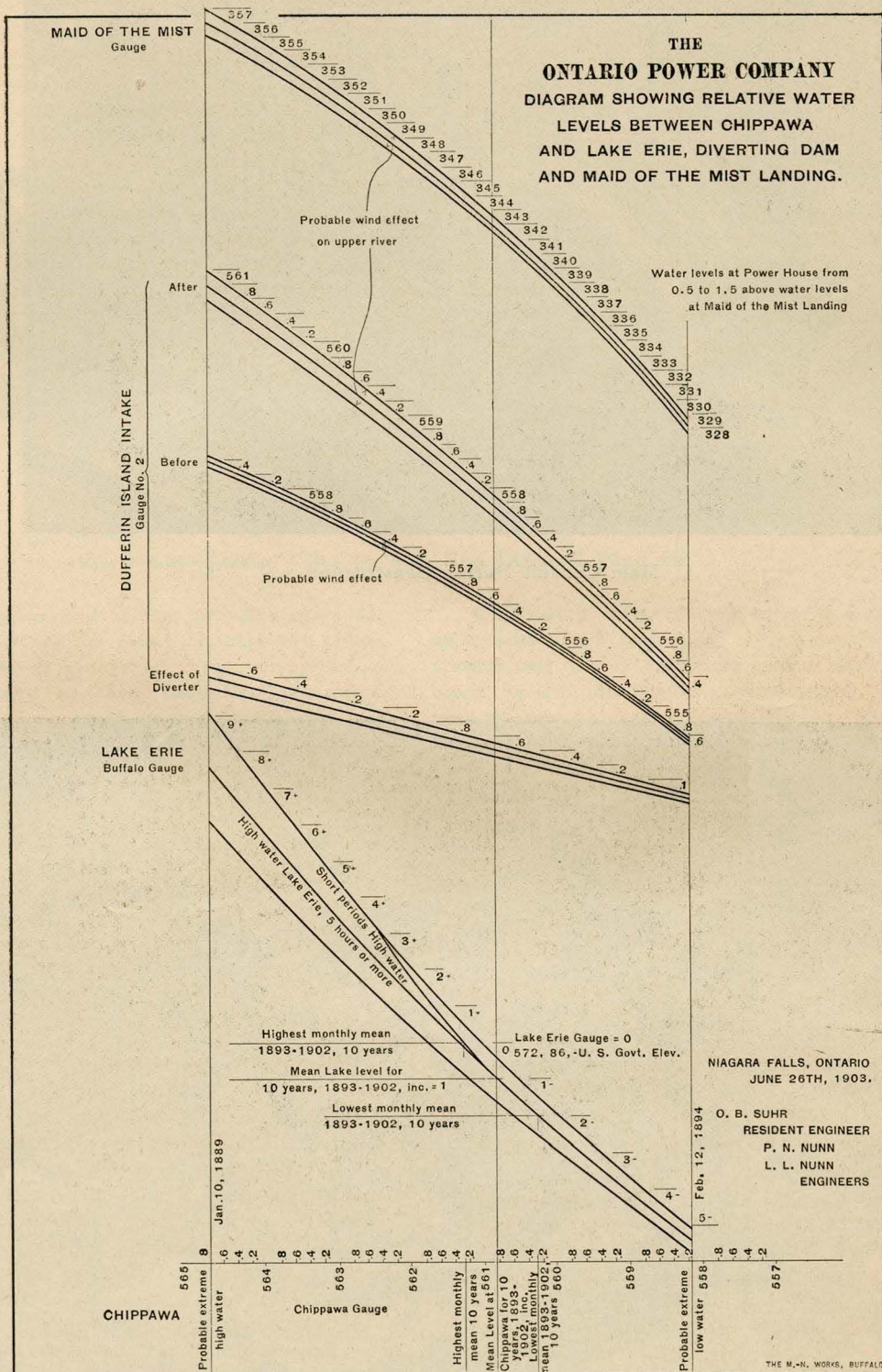
Although entirely feasible to use the vertical-shaft turbine, and, although restricted space at the power-house requires greatest floor economy, nevertheless horizontal units are employed on account of their freedom from step-bearings, their higher efficiency, and their greater accessibility. While step-bearings in certain places are entirely successful, as long since proved by screw propellers, and more recently by vertical steam turbines, yet at best they entail much auxiliary apparatus requiring especial care and frequent adjustment. With high-head turbines they have an uncertain record to be shunned wherever continuity of service is essential.

To reduce load upon the step-bearing, the vertical unit is usually of highest permissible speed. While efficiency at the generator is favored by this high speed, the effect upon the turbine is diametrically opposite, and usually many times greater. This is because highest efficiency and durability seem to require "normal" action—a radial relative direction of bucket entry—and narrowly limited relative dimensions of runner. At such reaction peripheral velocity of runner (the components of which—diameter and rotation—are inversely proportional) is fixed by head. At such relative

dimensions power is proportional to square of diameter; hence, inversely proportional to square of rotation. Increase of rotation, therefore, means disproportionately great decrease of power or abandonment of ideal reaction and relative dimensions. When carried to the extremes usual with vertical units, it results in inefficiently high reaction and reduced area of discharge, unfavorably abrupt changes of direction in buckets, and a wastefully distorted and over-worked wheel. To such an extent is this distortion carried to meet especial conditions that it is rare to find a high-

therefore accessible for lubrication, adjustment or repair. Excepting runners and gates, every moving part is in plain sight, and, by the ready removal of a single ring, even the guides themselves are exposed for cleaning or replacing. This arrangement, in strong contrast with that of the vertical type, with its several floors, intervening stairs and dark corners, will, it is believed, appeal to every power-house operator.

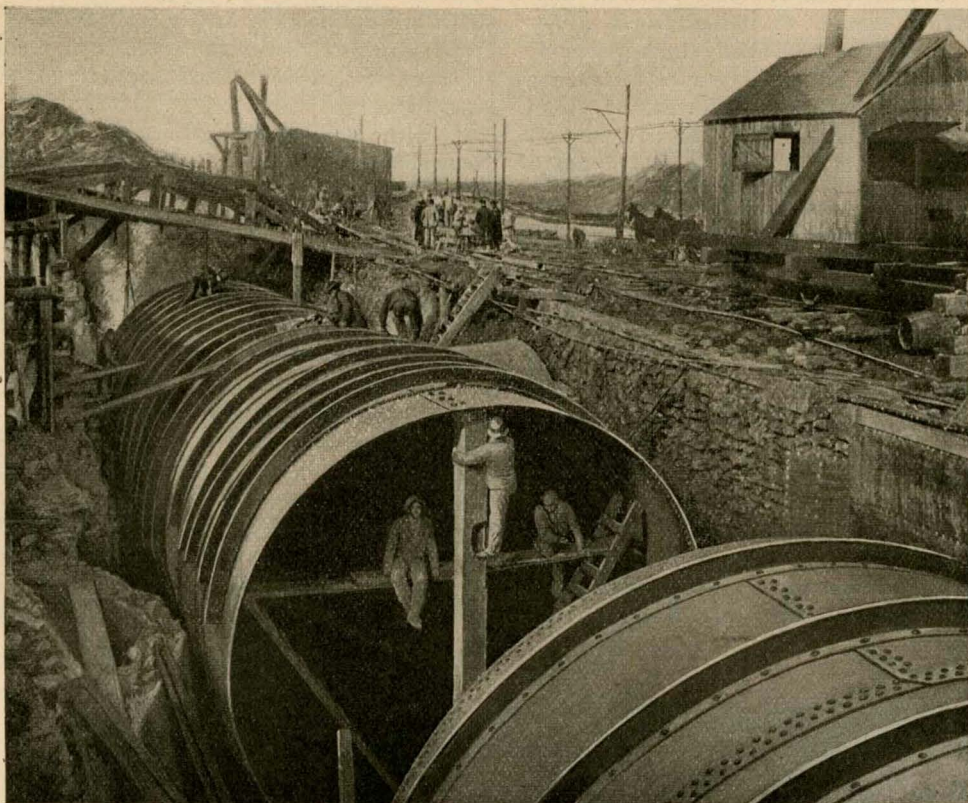
In the general arrangement of the works, symmetry and centralization of control are predominant characteristics.



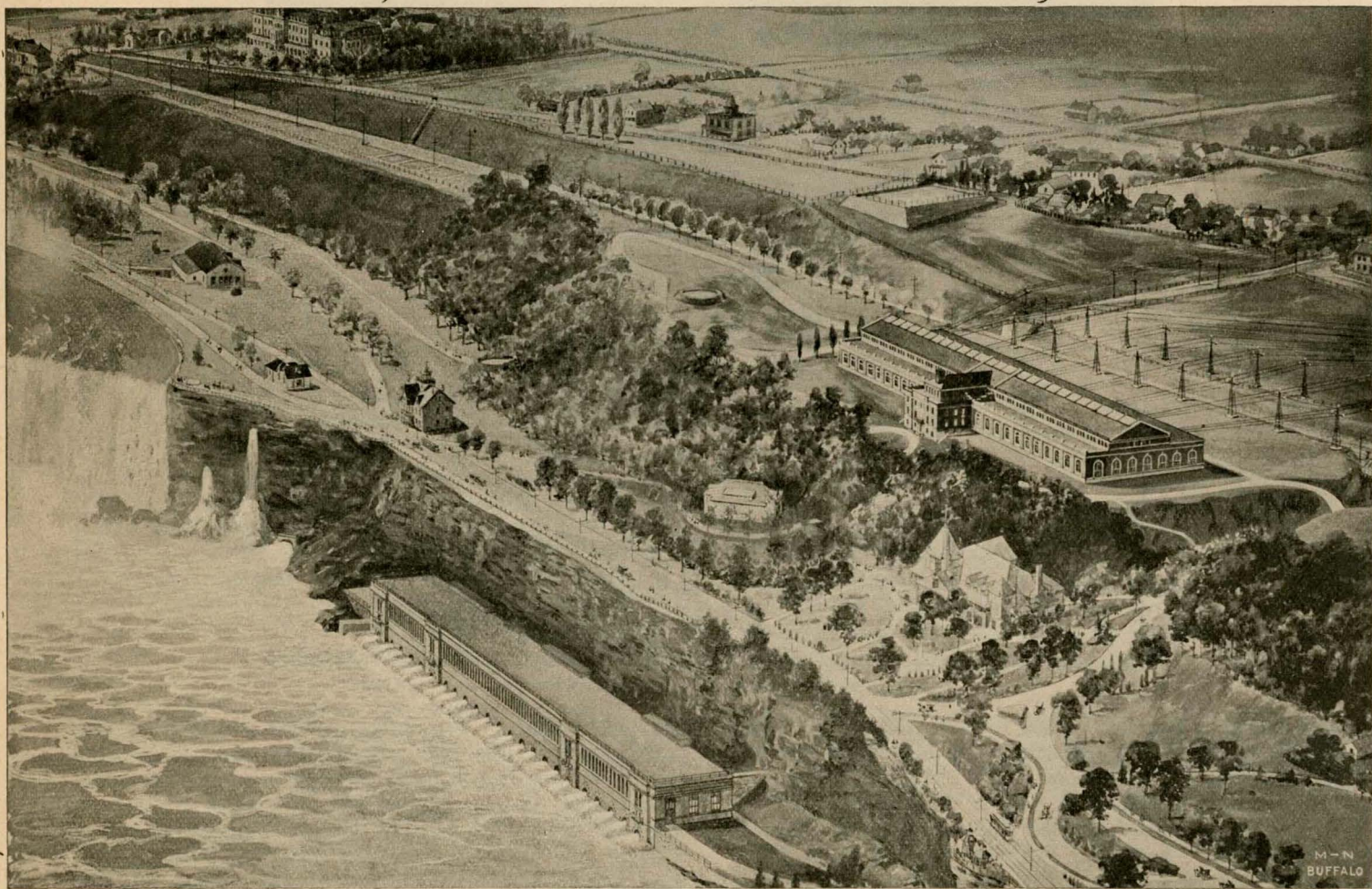
head turbine possessing nearly the efficiency or durability possible if correctly proportioned. In the present case the speed selected permits almost exact "normal" reaction and ideal proportions without sacrifice at the generator.

Gratifying accessibility has been obtained by compact arrangement of generators and turbines, with ample clearances and good light, upon the main floor of the station and in full sight not only of the immediate attendant, but also of the chief operator from his post upon the gallery above. As explained, the entire gate-rigging is external;

The generating and distributing stations are parallel, and nearly 600 feet apart, with 260 feet difference in elevation. On account of limited space the generating station is but 76 feet wide, though when completed it will be nearly 1,000 feet long. Down the centre of this building, side by side in a single row, stand the generating units with turbines next their source of supply. The space between them and the rear wall is occupied by a gallery upon which stands the row of oil-pressure governors, each almost over the end bearing of its turbine.



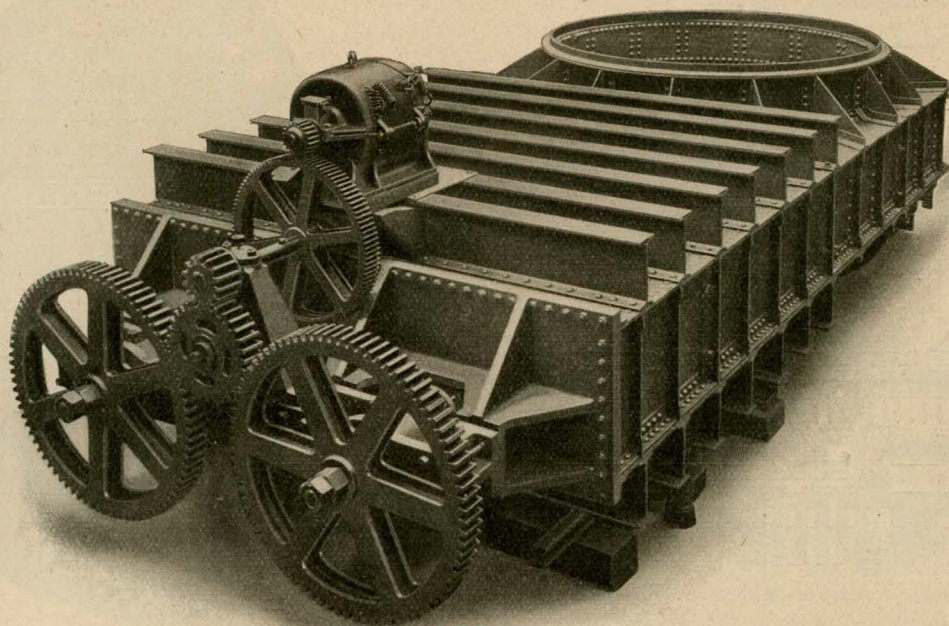
Main Conduit During Construction.



Bird's-eye View, showing Generating and Distributing Stations complete for 200,000 Horse-power.

The distributing station, wider and shorter than the power-house, is divided into three longitudinal bays, or five main sections. The narrow front bay contains the switches, bus-bars, etc., at generator pressure; the wider rear bay contains those at transmission pressure. Between these stretches the main middle bay, divided transversely by a three-floor switchboard section into two long transformer-

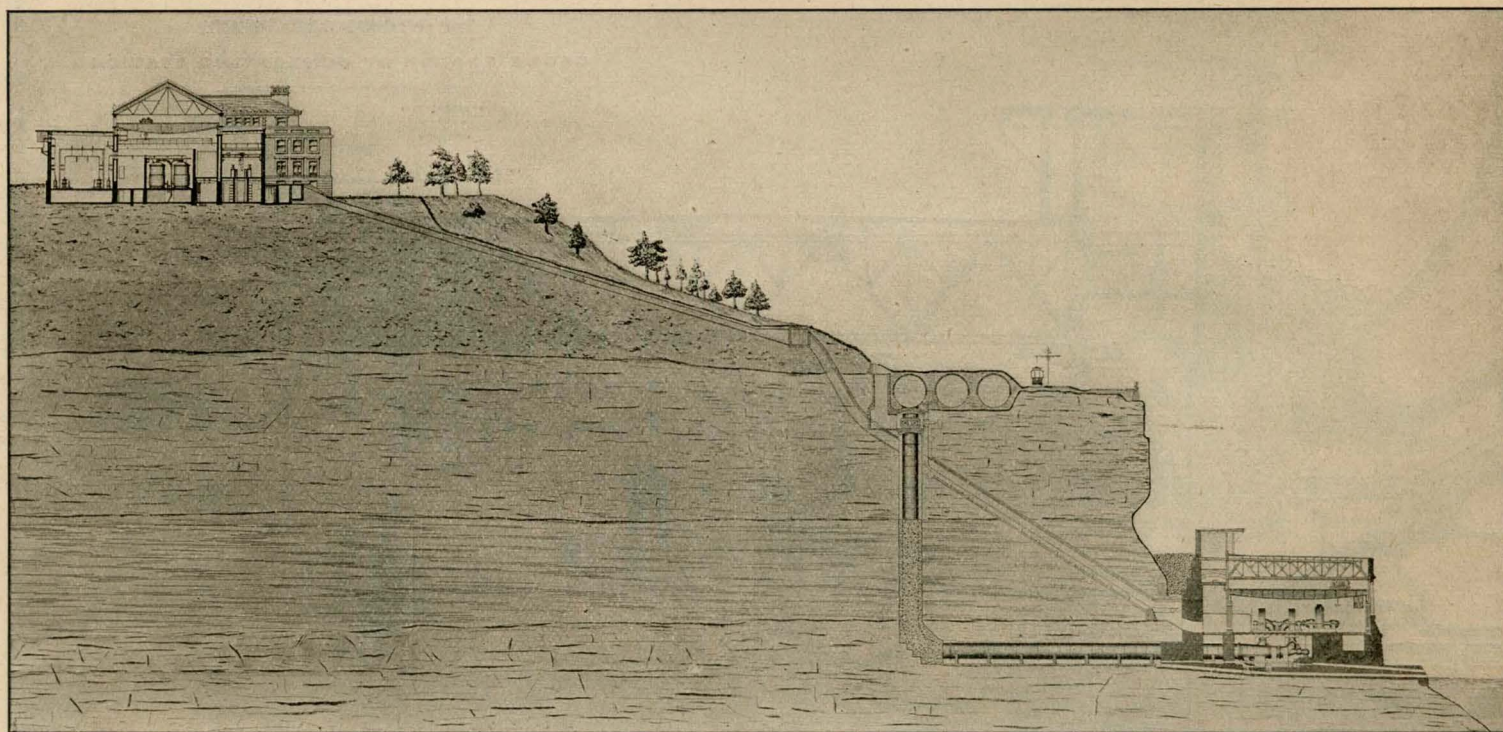
formers. They do not converge for the accommodation of switchboard at one or more centres where congestion prevents separation or adequate insulation, and in many installations causes the most disastrous accidents. On the contrary, they are laid quite regardless of switchboard, the switches and instrument transformers of which are then placed as required by the cables.



Electrically-operated Valve for Nine Feet Diameter Penstock.

rooms. The projecting central section provides space for the operating offices. Along the centre of these two rooms the transformers stand in groups of three, corresponding in position and capacity to their respective generators. Thus similar apparatus is arranged in rows parallel one with another and with the generating units.

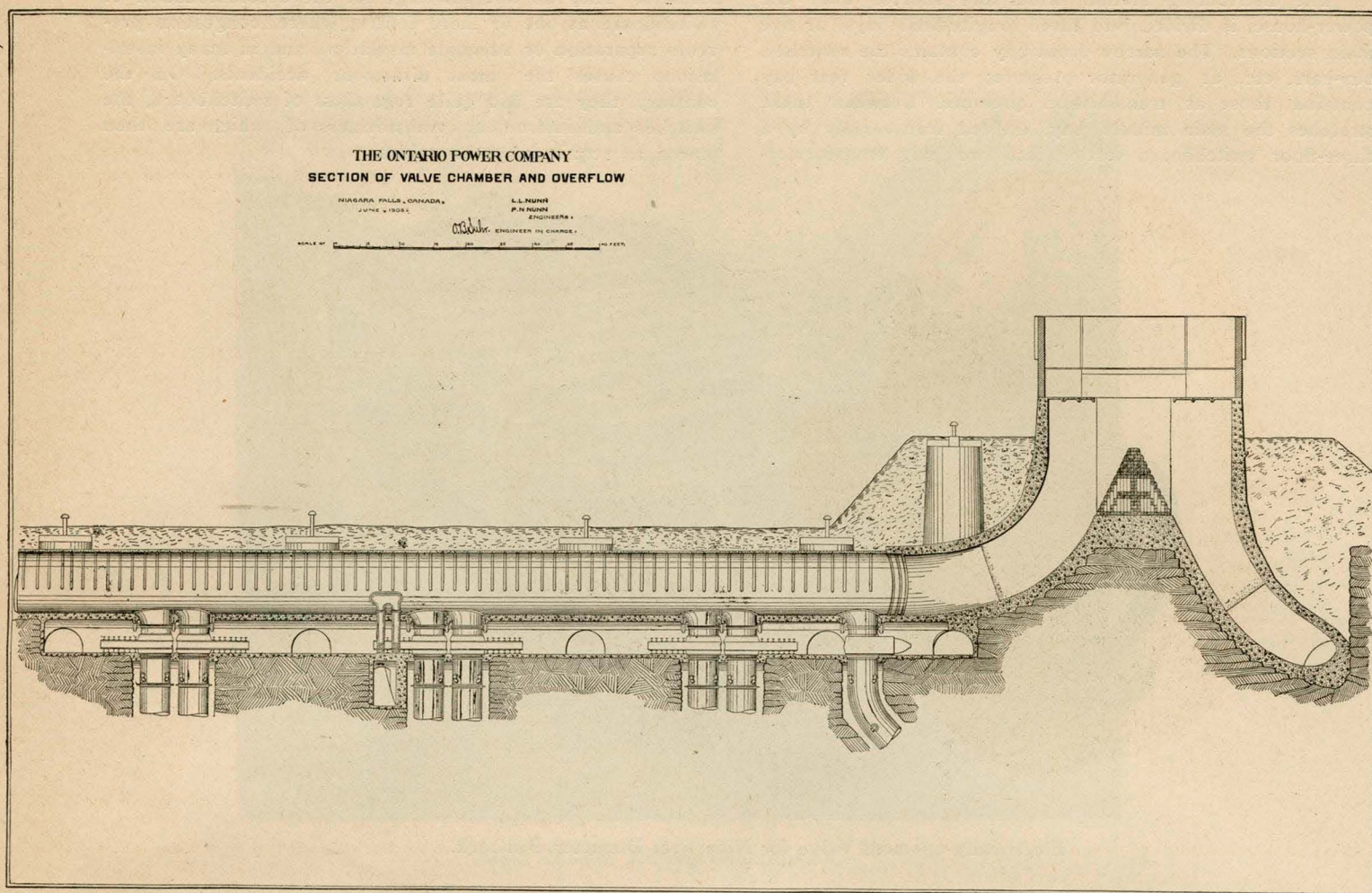
Unit values, corresponding to the generators in capacity and position, are maintained throughout. Thus each generating unit has its individual cables, switches and switchboard, section of bus-bars, transformers, interrupters, and high-pressure switches complete to the transmission, enabling independent operation as an isolated power-plant,



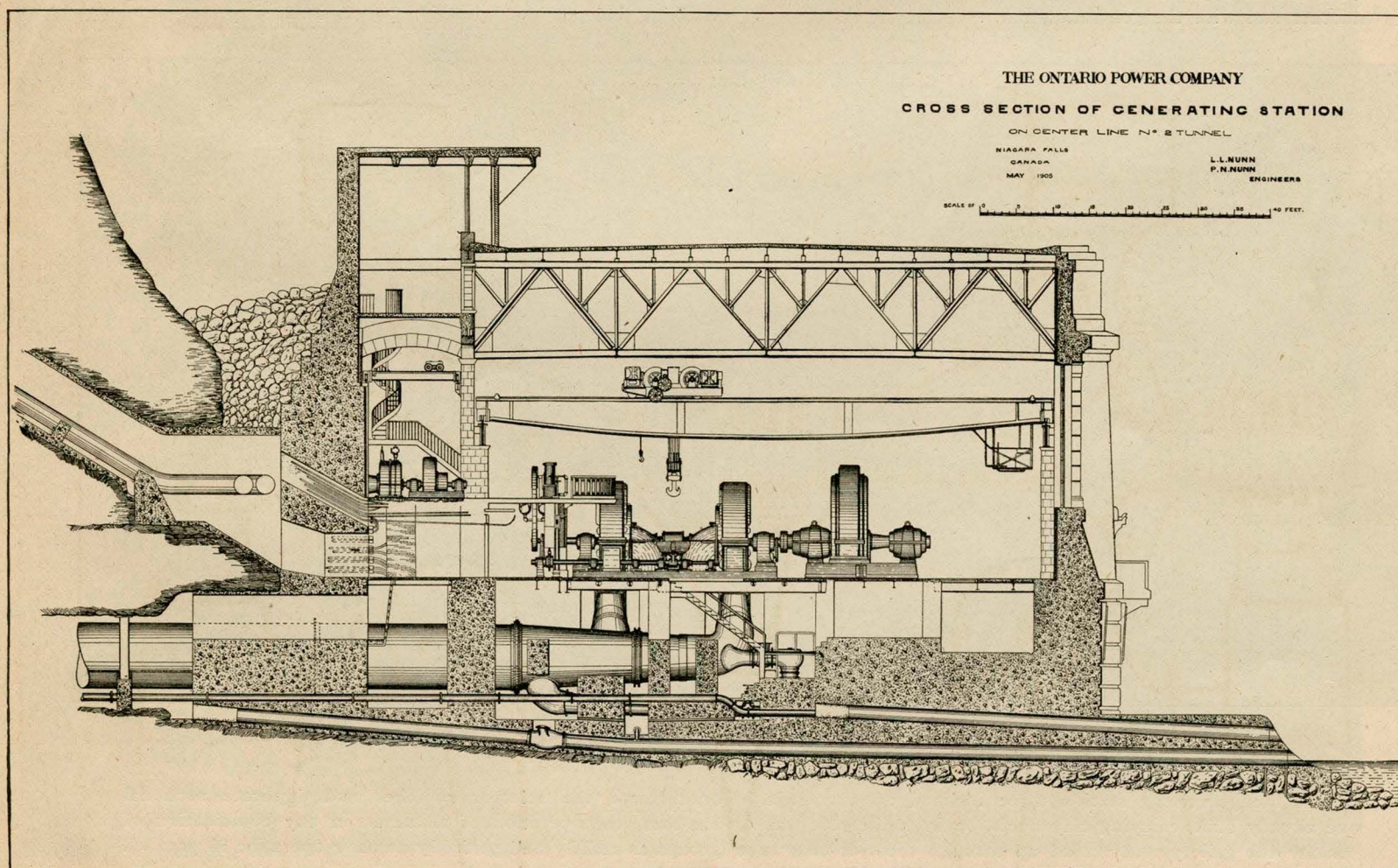
Section through Generating and Distributing Stations.

At the generating station three inclined cable tunnels, one already built, carrying clay ducts, begin at the rear wall beneath the gallery and extend up through the cliff and, as standard subway, on to the distributing station. The main cables, except as diverted by these tunnels, follow the shortest and most direct routes from generators to trans-

or, through the selector switches and duplicate sectional bus-bars, the operation of all units in any combination of groups as readily and perfectly as their operation in parallel. To this end a unit length of distributing station of similar relative position is devoted to the circuit and apparatus corresponding to each generator.

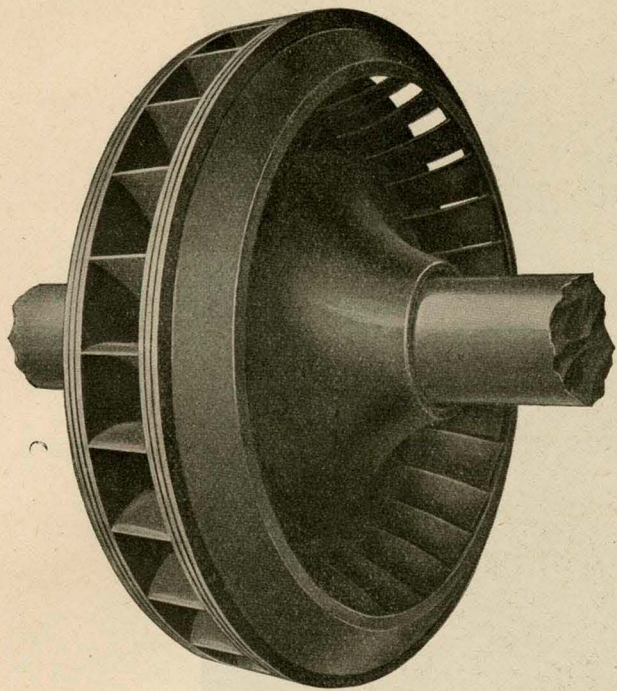


Section through Valve Chamber and Helical Spillway.



Section Through Generating Station.

From the above it may be seen that the arrangement is in parallel courses; that like apparatus is arranged in rows or courses parallel with the long axis of the generating and distributing stations; that the main circuits and the unlike apparatus performing the successive functions of these circuits form twenty-two courses transverse to the

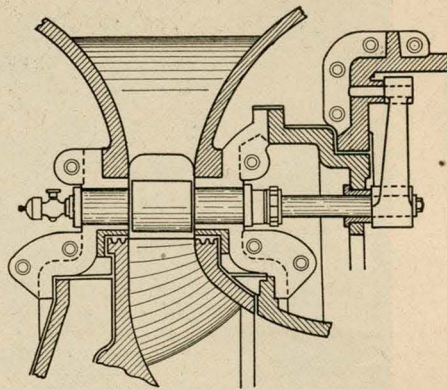


A Turbine Runner.

same, and that the courses of the two directions form, as it were, a rectangular or checker-board figure covering an area nearly 1,000 feet square. The arrangement of these courses in logical sequence provides the short and direct route for the main cables previously mentioned. Such symmetry of arrangement, while difficult to attain in a

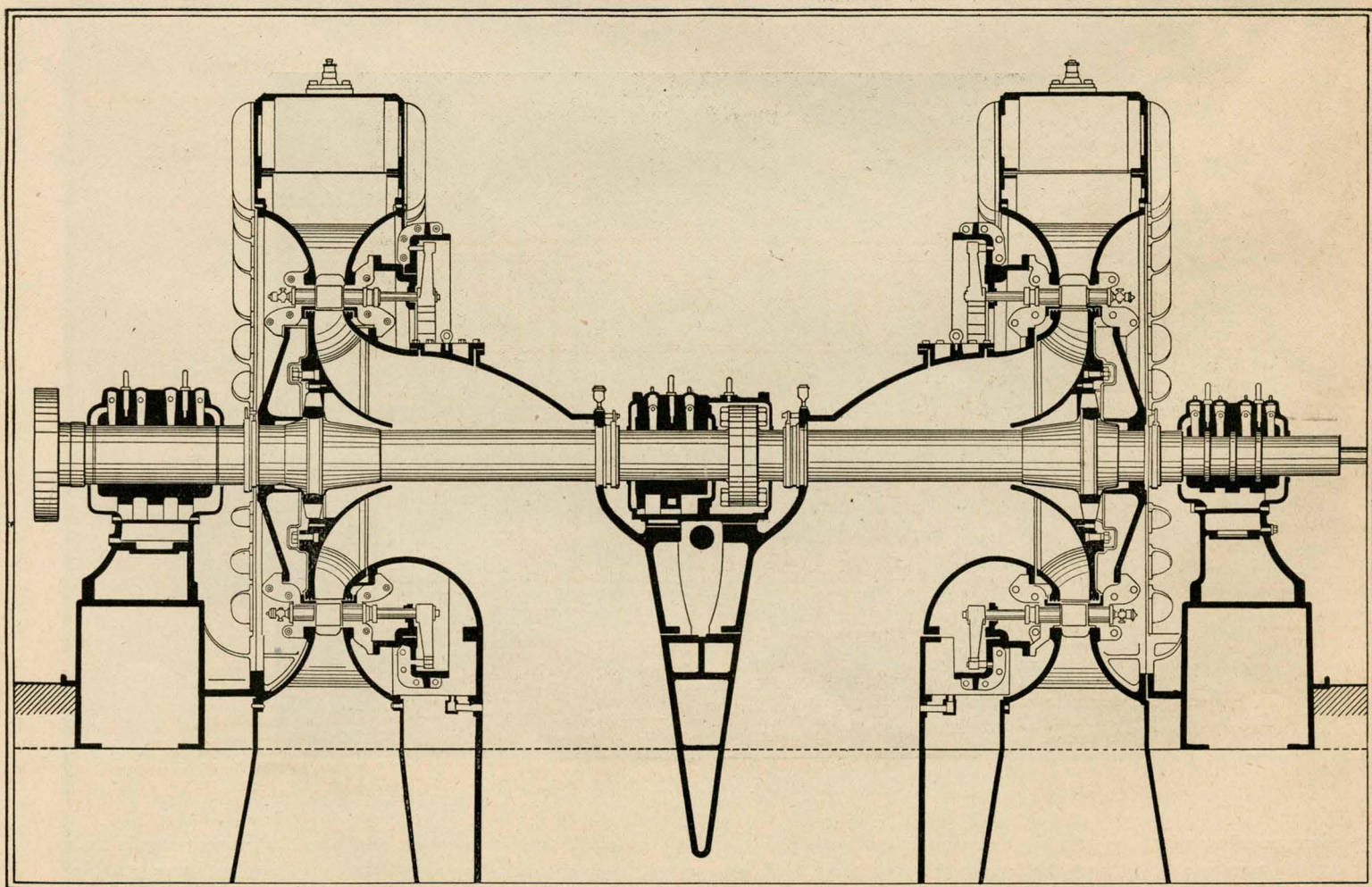
crowded plant or at points of congestion, is of marked value in emergency, especially in a plant of many units, and becomes vital when the units are of such dimensions that the accidental crippling of one costs the output of many smaller plants.

Where the cable tunnels commence, the power-house and gallery are widened toward the cliff. Immediately above the tunnel entrance are the main generator switches, and on one side the duplicate turbine-driven exciters and their



Operating Mechanism of Turbine Gate.

governors, and on the other the motor-actuated main field rheostats. In front of the switches are a few panels of switchboard carrying exciter rheostats and switches, controls for actuating penstock valves, and the necessary circuits and apparatus for a limited local distribution. Relief valves and small drainage-pumps are the only operating machinery beneath the main floor, while upon it, in addition to the generating units, there are only duplicate electrically-driven pumps supplying the storage tank and transformer cooling coils at the distributing station. For air circulation and ventilation and to avoid dampness from spray as well as to ensure cool generators in hot



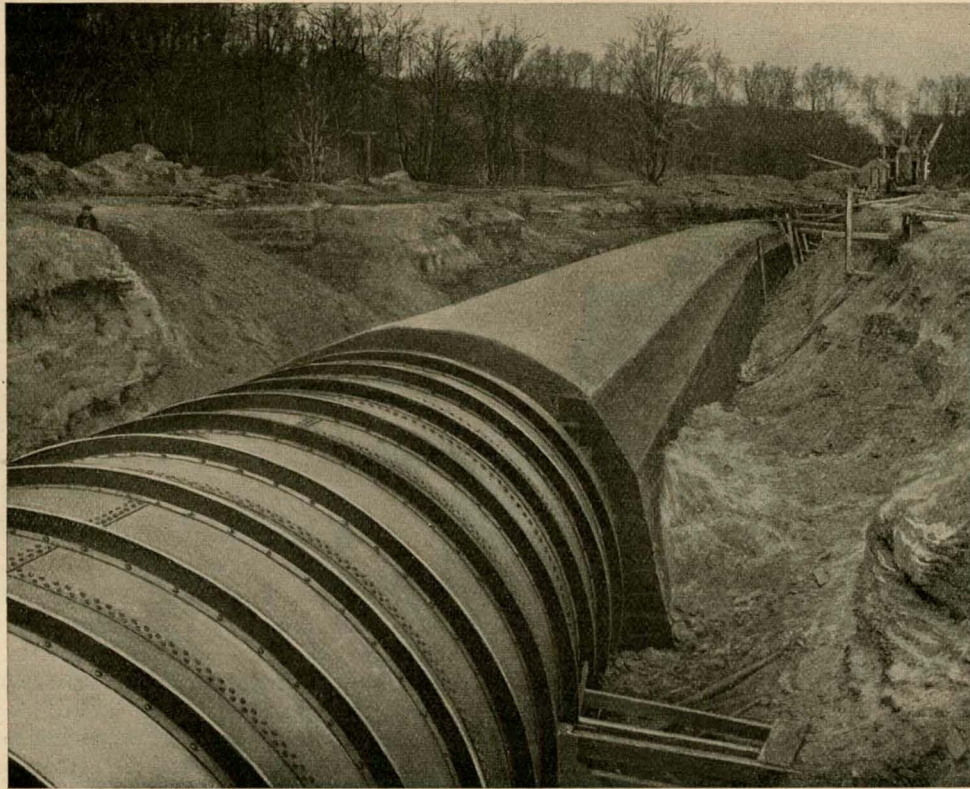
Sectional Detail of Horizontal Turbine.

weather, a cold air supply to each generator is provided from a sub-floor chamber communicating with external shafts and heated air escapes through large roof ventilators.

At the distributing station the low-pressure bay contains upon the main floor the 12,000 volt automatic oil

record-making thermometer giving the continuous history of internal economy.

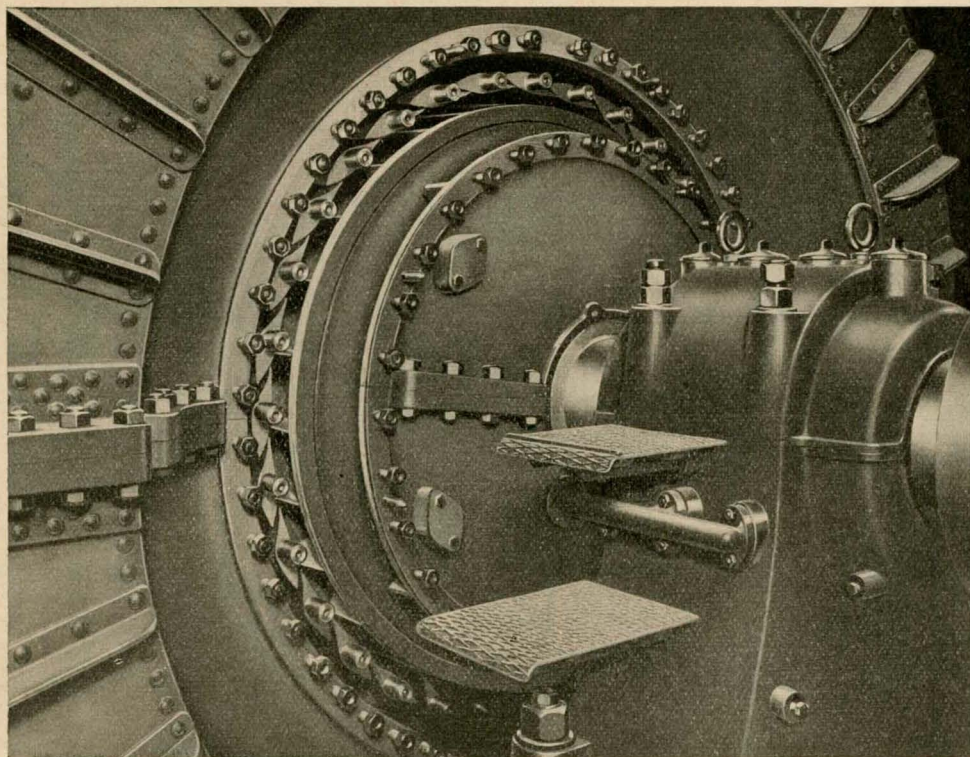
The switchboard section, occupying the centre of the distributing station has four floors, of which the basement serves as a centre for the piping systems, and gives room



Eighteen-foot Diameter Conduit, showing Concrete Envelope.

circuit-breakers in double column, and in the chamber beneath only the sectional duplicate bus-bars and their immediate connections. In the transformer-rooms the transformers stand in pits six feet below main floor level, and parallel with them adjacent to the high-pressure bay are

for conduits and cableways for wiring. On the main and the mezzanine or gallery floors, marble slabs carry record-making and integrating instruments, terminal boards with fuses for the control cables, and other adjuncts of the switchboard above. Upon the upper floor is the switch-



Swivel Gate Exposed by Removal of Cover Ring.

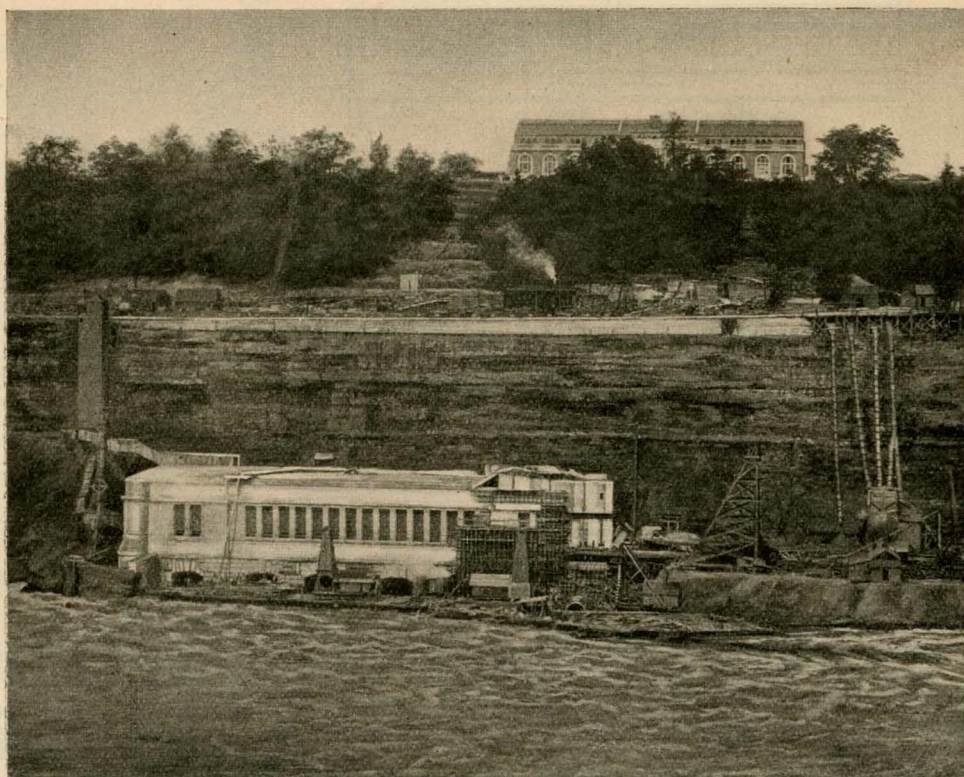
corresponding pits for static interrupters or other protective apparatus. Beneath both and between their foundations are accommodated the several systems of piping for water, oil and drainage and the main cable-ways to the transformers above. Each transformer is fitted with a

board and control chamber, and here instrument-stands and control-pedestals supplant both the conventional marble slabs and the later bench-board. Each of the twenty-two instrument-stands, which are arranged approximately in a semicircle about a central point, corresponds to a definite

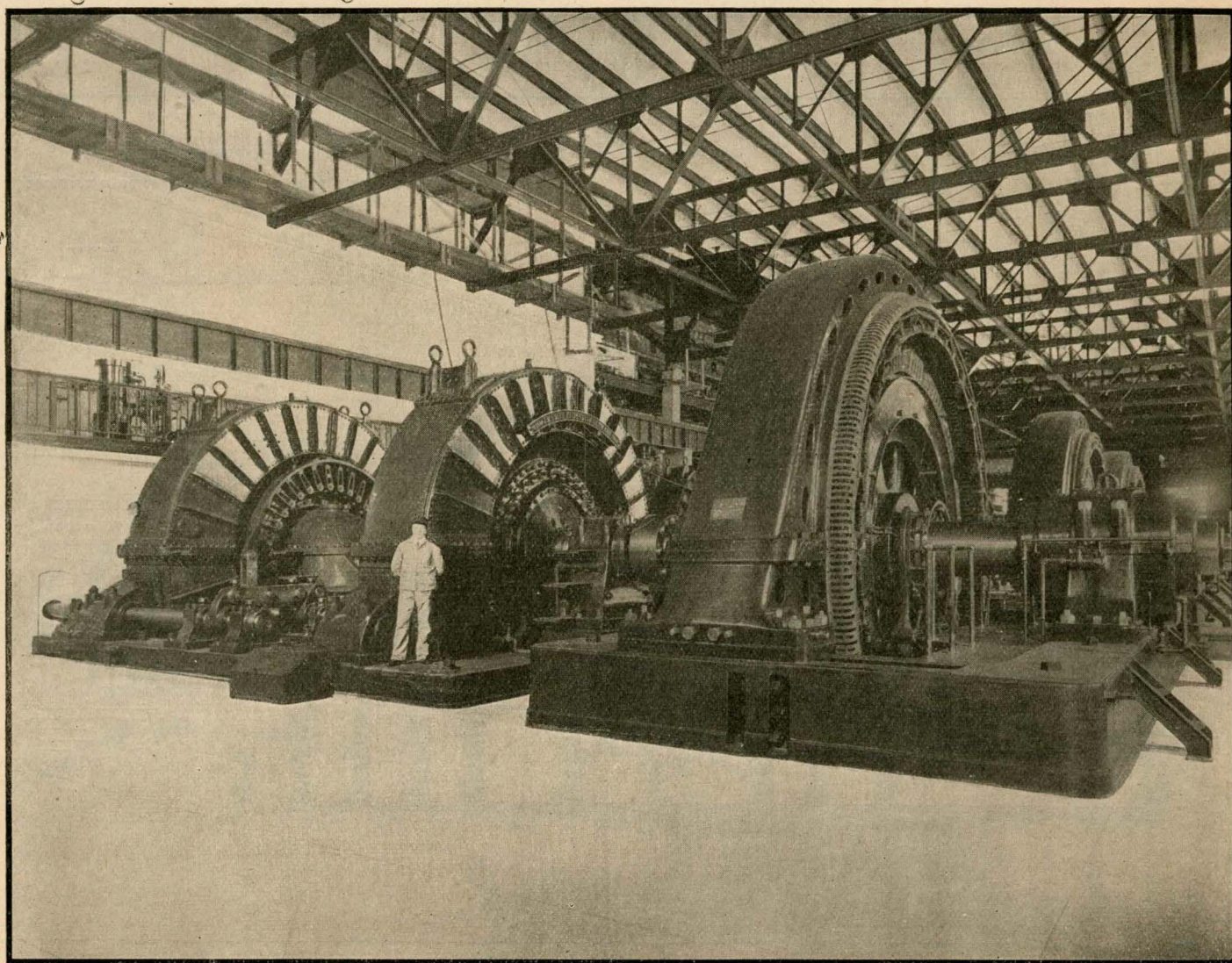
unit, carries nine indicating instruments, and faces its twelve-point control pedestal. Doors upon the four sides lead to balconies in the four other divisions of the building of which this room is the centre; those at the sides to

balconies extending the full length of the transformer-rooms.

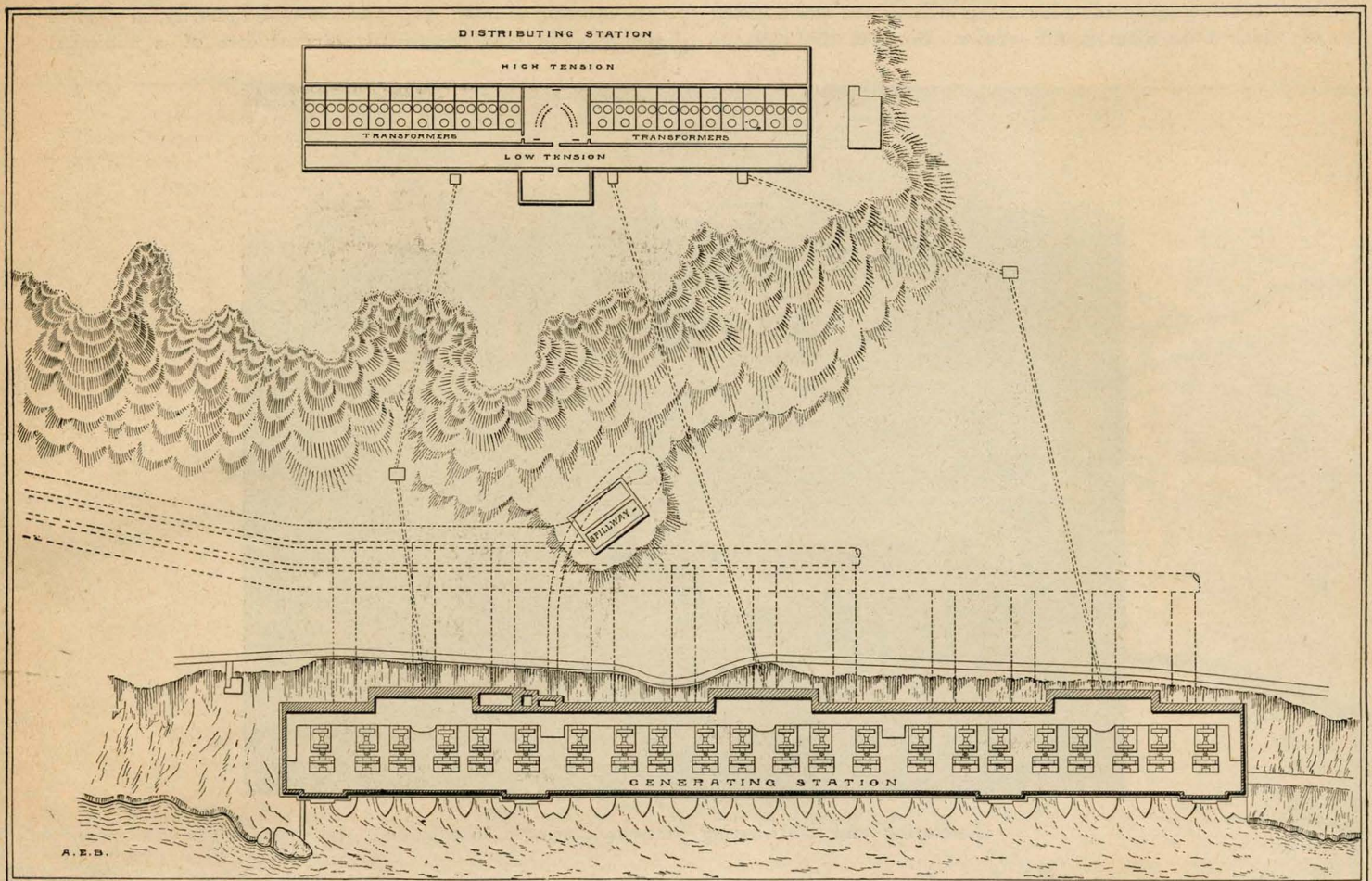
Centralization of responsibility and authority, at defined points within the immediate personal care of a minimum



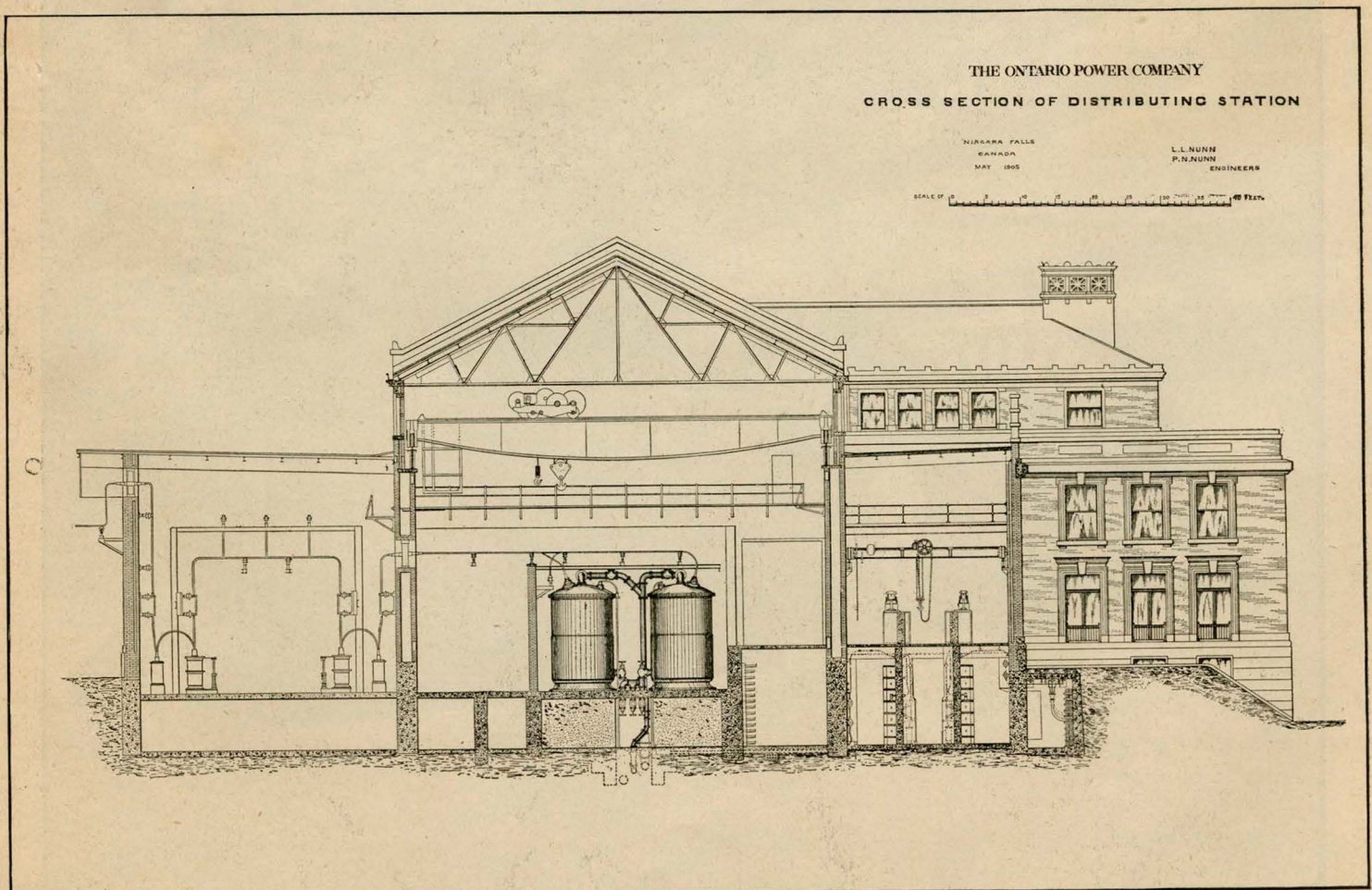
Generating and Distributing Stations During Construction.



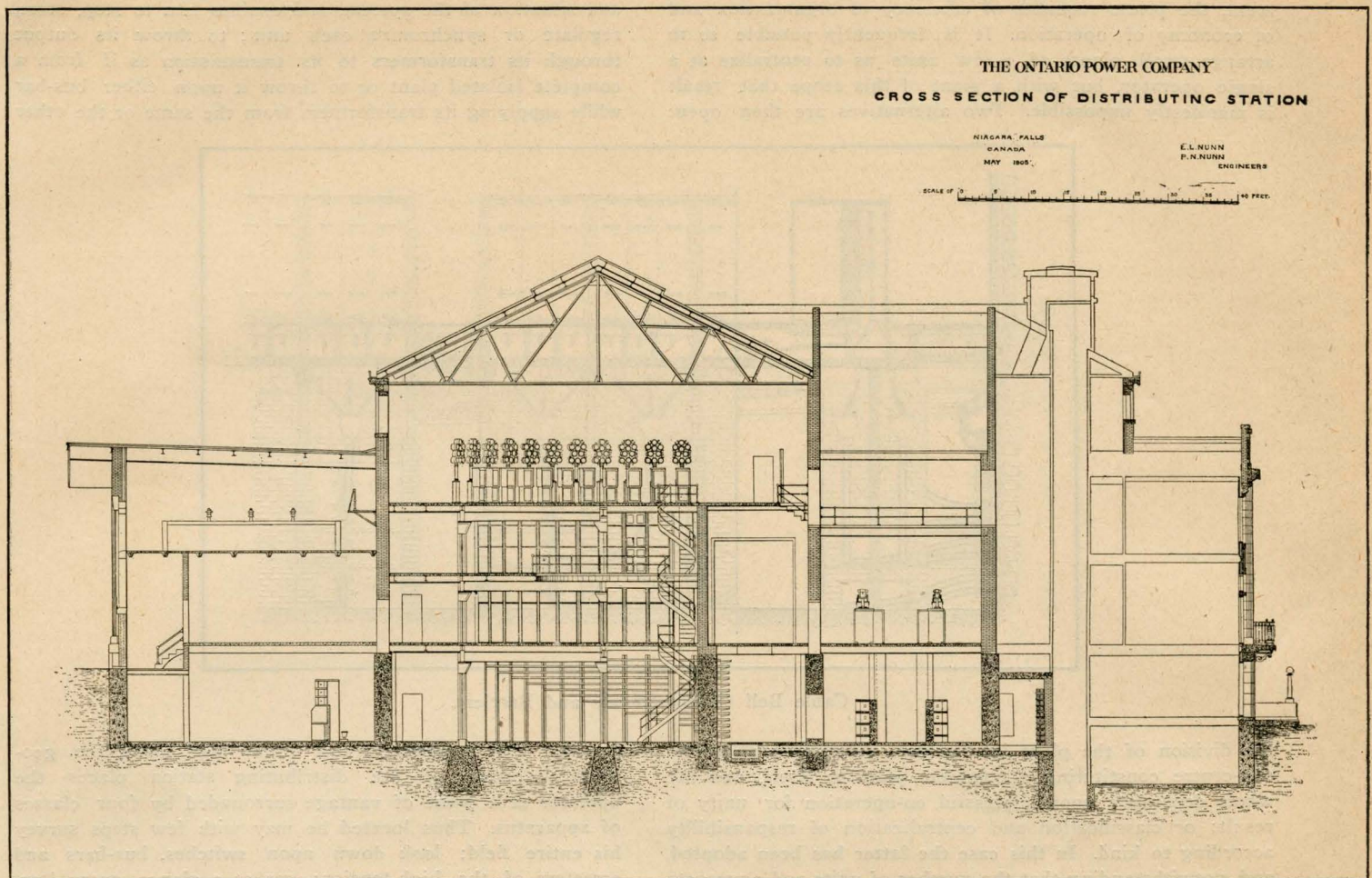
Interior of Generating Station.



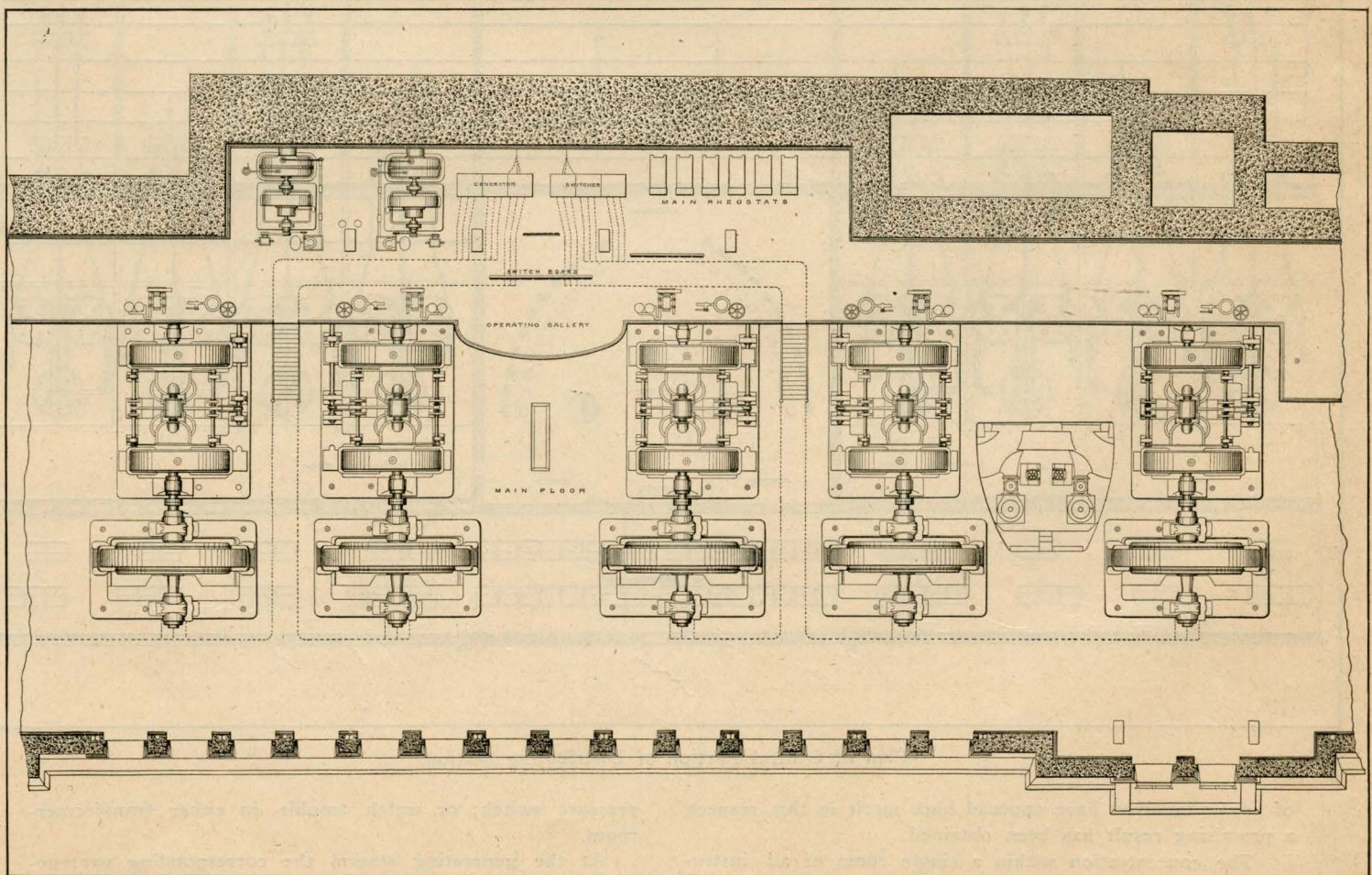
Plan of Electrical Works.



Section through Transformer Room.



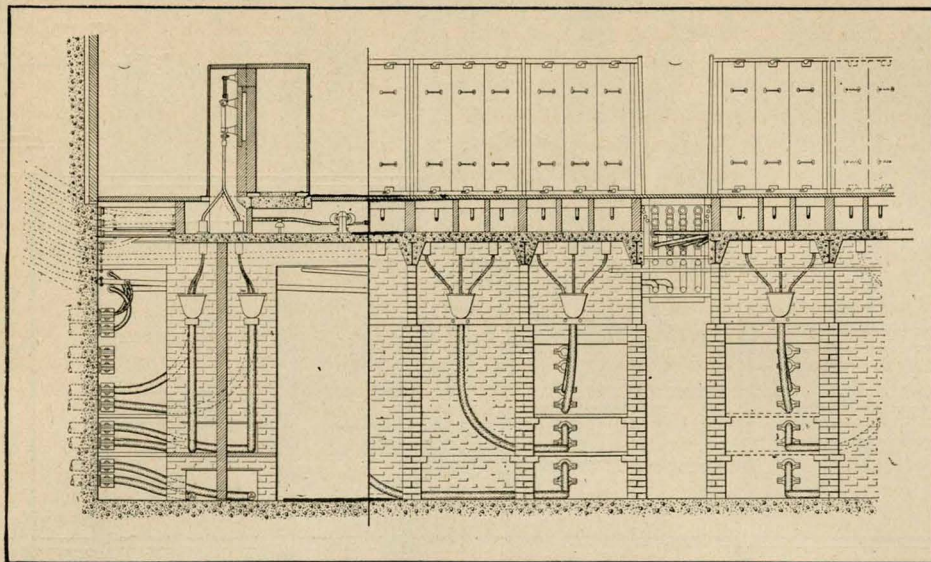
Section through Control Chamber.



Plan of Generating Station, Units 2 to 6.

number of chief operators, is, next to simplicity of arrangement, the prime requisite of efficiency of organization and of economy of operation. It is frequently possible so to arrange small plants of a few units as to centralize at a single operator, but with a plant of this scope that result is manifestly impossible. Two alternatives are then open:

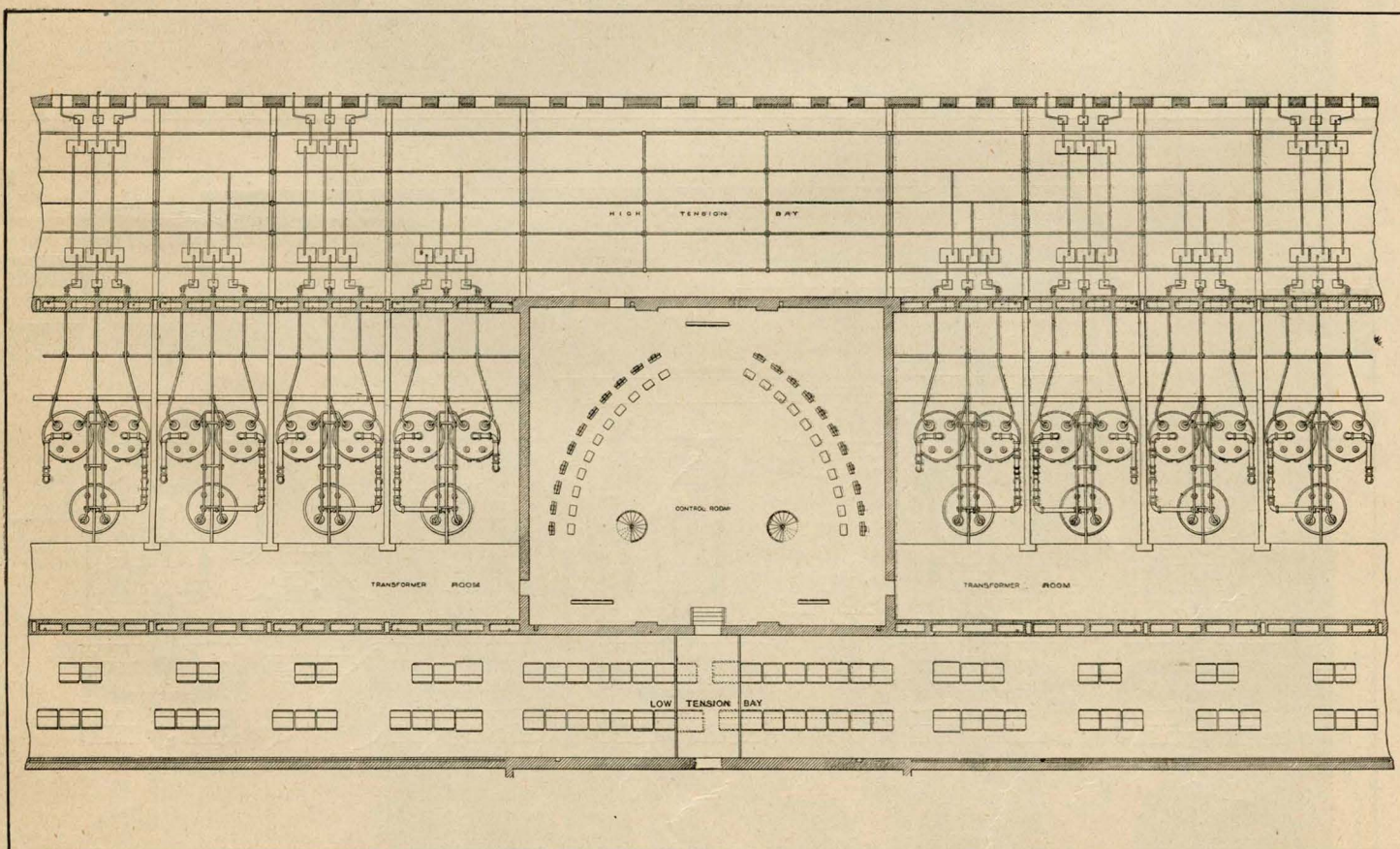
information and perfect control of every electrical circuit and situation of the system, and enables him to stop, start, regulate or synchronize each unit; to throw its output through its transformers to its transmission as if from a complete isolated plant or to throw it upon either bus-bar while supplying its transformers from the same or the other



Cable Bell Compartments and Barriers.

the division of the plant into several parts, each about its sub-centre constituting a complete plant in itself, and the whole dependent upon successful co-operation for unity of result; or classification and centralization of responsibility according to kind. In this case the latter has been adopted, and, notwithstanding that the number of units and aggregate

bus-bar. The location of this room high up at the geometrical centre of the distributing station places the operator at a point of vantage surrounded by four classes of apparatus. Thus located he may with few steps survey his entire field; look down upon switches, bus-bars and arresters of the high-tension; see at a glance every low-



Plan of Central Portion of Distributing Station.

of power involved have opposed high merit in this respect, a promising result has been obtained.

The concentration within a single room of all instruments and control—the brain of electrical operation—provides the operator in a quiet and secluded place both full

pressure switch; or watch trouble in either transformer-room.

At the generating station the corresponding vantage-point is the gallery, where on one side the operator has the motor-driven rheostats and a few paces distant the com-

mutators and governors of the exciters, and on the other side in plain sight the row of main governors with their adjuncts; while from the little switchboard before him he has electrical control of penstock gates, and, when necessary, manual control of turbine speeds, exciter pressure and field charge. Moreover from this position he can see all generators and turbines, and, by signal, at least, can direct his assistants; little, in fact, is likely to call him to the main floor unless it be an occasional refractory journal or collector brush.

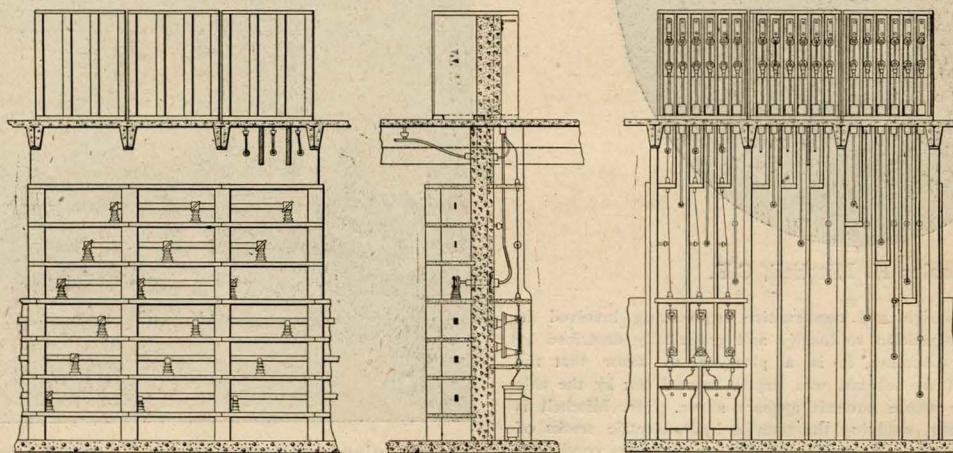
In accomplishing the centralization of switchboard simultaneously with the broad and symmetrical distribution of main circuits and switches already described, distant electrical measurement and control have necessarily been employed to an unusual extent. Pressure and current transformers, essential to the many instruments and relays beyond those necessary at generating station and high-pressure room are mounted in the bus-bar chamber. The innumerable and long conductors, necessary to extend over the intervening distance from those to the many instruments of the switchboard and to convey back the power from relays and control buttons to automatic switches have been gathered into substantial cables and laid in metal conduit.

The basement of the central bay along its low-pressure side forms a wiring chamber supporting a railway track upon the main floor above. Through this wiring chamber transverse to the general direction of the main cables and

a height of 23 feet by masonry fire-walls. Each individual transformer is in a boiler-iron casing designed to withstand 150 pounds per square inch explosive pressure. Each case communicates through an eight-inch pipe from its top with a special drain for free vent in case of accident, as proposed before the Institute some time ago; but here the supply is cold oil instead of water as then proposed. With these precautions it is believed that the transformers have been surrounded with an environment unprecedented as to safety.

The power from each generator is conducted to its switch through three single-conductor braided cables carried by line insulators and isolated by shelf barriers in a subway beneath the floor. From the switches the three conductors pass to a bell chamber, where, between individual barriers, they are united into two parallel three-conductor lead-covered and armored cables before entering the tile ducts of the cable tunnel. Around the few bends at manholes each cable remains within its compartment, between horizontal or vertical barriers as required. At each point where a circuit enters the distributing station, a manhole maintaining the same segregation and communicating with the bus-bar chamber is provided for the change from three-conductor to single-conductor cable. After entering the building the cables pass between vertical barriers as before beneath and through the floor to the switches above.

Bus-bar structures are composed entirely of concrete, with mortised reinforced-concrete shelf-barriers between



Front, Rear and Section of Bus-bar Structure and Switches.

opening at its centre into the control section, these cables and those for both continuous and alternating current local service are carried into the basement beneath the control section, and, rising through the recording floors, end at terminal boards below their respective instruments and relays. Carried thus far, distant control has been still further applied by the use of motor-driven rheostats for both generators and exciters, electrically operated circuit-breakers for field circuits, and speed controllers for governors whereby, as previously mentioned, turbines may be started, stopped or regulated from the control chamber as well as from the gallery at the generating station.

The isolation of electrical apparatus and conductors by incombustible walls or barriers against spread of oil or arcs, for protection from fire and from each other, is of importance proportional to the power and investment involved. Neglect of this precaution has caused many of the most disastrous electrical accidents, and has recently taught several bitter lessons. Some rather extreme measures here taken for its more complete application may be of interest. The five sections or rooms, heretofore mentioned, forming the distributing station, are of concrete-and-steel fireproof construction, separated by full-height masonry walls, with intervening air-spaces. No windows and but few doorways (these latter protected by fire-proof doors, usually closed) penetrate these walls.

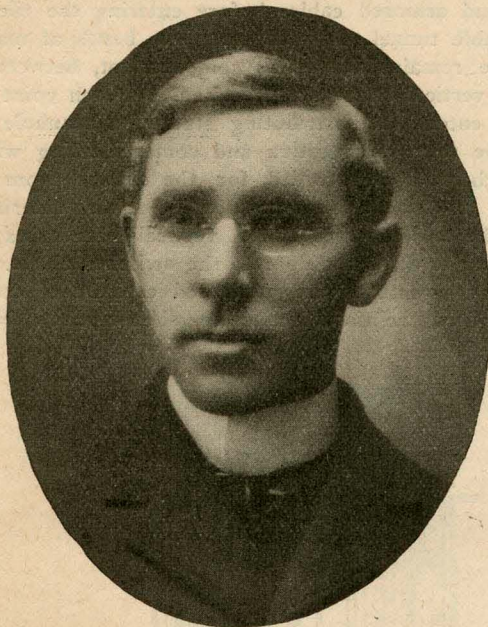
The transformer pits already mentioned, each containing a bank of three transformers, are isolated and extended to

bus-bars. Connecting leads pass through the wall forming the centre of the structure, and thence in compartments formed by vertical barriers of the same material, directly up to the switches above. Instrument transformers are also installed within similar individual compartments, and these whole structures, like those of the switches, are closed by fireproof doors. Control cables are laid in metal conduit throughout their courses except in the wiring chamber beneath the track, where they are arranged upon metal shelf-pans filled with dry sand into which connecting conduits dip.

Of the features here presented, it is believed that the type of intake, the symmetry of arrangement, centralization of control, and almost perfect isolation of apparatus represent, to some degree at least, distinct advances in power-plant design; and, while few works of such dimensions may be built for many years, if ever, the purposes and methods thus briefly presented may, until superseded by the next advance, be of service as suggestions to other designing engineers of similar works. The unusual, even enormous, volumes, both of water and of power, involved not only in the individual units, but also in the aggregate, have presented new problems heretofore unprovided for in standard sizes of apparatus, thus necessitating the development of larger capacities and the creation of new types. Hence the work of designing and building has been burdened with incessant test, re-design and adaptation unknown in more conventional engineering. Therefore, it is believed that upon

no similar work in this country, since that of the Niagara Falls Power Company years ago in the infancy of electrical power, has devolved such a burden of investigation, invention and original design.

It has been suggested by an officer of the Institute that any account of this work would be incomplete without mention of those mainly responsible for it. Justice to all is here impossible, but a few may be named. Mr. O. B. Suhr has from the beginning been in charge of the engineer corps, and to him is largely due the harmony of design. Mr. V. G. Converse, Mr. C. H. Mitchell, and Mr. J. B. Bailey are chiefs of the electrical, mechanical and field departments respectively, and Mr. J. R. Harsch of the clerical work of the engineers.

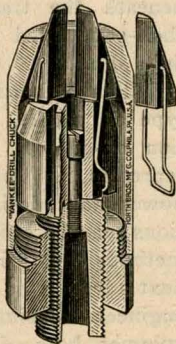
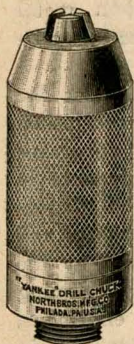


Charles H. Mitchell, C.E.

While the original design and constructive engineering involved in the really magnificent installation so lucidly and graphically described by Mr. Nunn, was purely American, it is a pleasure to know that the mechanical engineering of the scheme, was largely carried out by the able young Canadian engineer whose portrait appears above. Mr. Mitchell is now on a six months' tour, studying the notable hydro-electric works of Europe. The data thus gathered, having relation to analogous conditions in this country, will be set forth exclusively, in a series of articles in the columns of "The Canadian Engineer."

DRILL-CHUCK IMPROVEMENT.

The drill-chuck, as illustrated below, was designed to meet the demand for a tool-holder which can be adjusted by hand. It is accurate, durable, and guaranteed to hold true; is compact, strong, well proportioned, and of simple construction. The body is made of the best grade

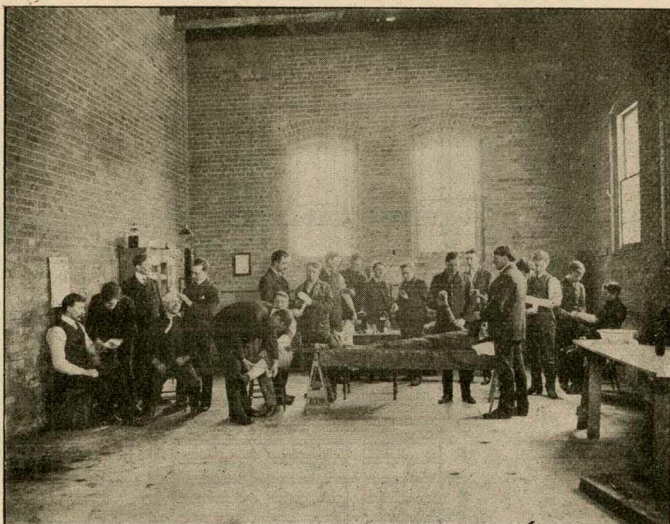


machinery steel, while the jaws are made of drill-rod steel, not liable to break. In hard service this chuck is very efficient, and will practically hold a drill as tight after long and continued use as it did when new. It is especially adapted for light and rapid drilling where accuracy is required. North Bros. Manufacturing Co., Philadelphia, are placing this valuable little tool on the market.

FIRST AID TO THE INJURED.

In our January issue we described very fully the latest first aid methods in treating persons shocked by electricity. Through the interest of Mr. Gray, first aid superintendent at the above works, we are enabled to give an illustration of local class practice in connection with the very efficient system in vogue at Davenport. Mr. Gray—who stands third near the wall to the left—is conducting exercises in (1) the recognition and treatment of shock, (2) applying temporary splints to broken limbs, (3) controlling severe hemorrhage, (4) different methods of inducing artificial respiration.

The organization of the first aid corps is carried out with almost military precision. In each department of the works, including the office staff, one or more men have been selected, and given a course of lectures by the works doctor. Upon passing an examination in the theory and practice of first aid, they are each entitled to wear a Red Cross Badge, which is worn on the left arm during working hours; thus making it an easy matter to locate them in case of accident. When an accident takes place, the first aid men in the department where it occurs, take the injured person to the ambulance room, where they straightway attend to him, and at once send for the doctor if deemed necessary.



Ambulance Room, Canada Foundry Company's Works, Davenport, Toronto.

The following is a list of appliances and material in the ambulance room; which are furnished by the company, and are free of access to members of the corps only:

- | | |
|--|-------------------|
| Operating table. | Hot water bags. |
| Stretcher. | Hospital bed. |
| Instruments for performing minor operations: | |
| Forceps. | Scissors. |
| Needle holders. | Tourniquets. |
| Needles. | Scalpels. |
| Ligatures (silk and silk worm gut). | |
| Solutions for dressing and antiseptic purposes: | |
| Carbolic acid. | Boracic acid. |
| Picric acid. | |
| Evaporating lotions: | |
| Alcohol. | |
| Material for dressing wounds: | |
| Antiseptic gauze. | Collodion. |
| Absorbent cotton. | Cocaine solution. |
| Bandages. | Green soap. |
| Antiseptic powders. | Adhesive plaster. |

Severe illnesses and even deaths have been prevented by these humane Red Cross organizations, and to our knowledge much good has been accomplished by this famous foundry company's corps. Both the staff and the company are to be congratulated on their noble work.

Every industrial establishment of magnitude in Canada should have an efficient ambulance corps.